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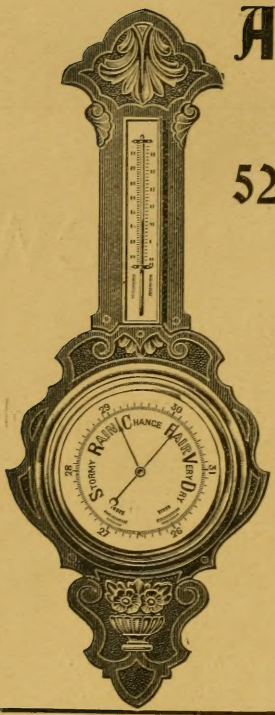

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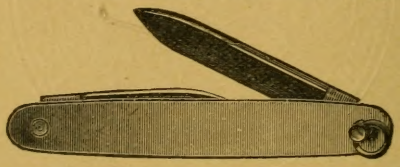

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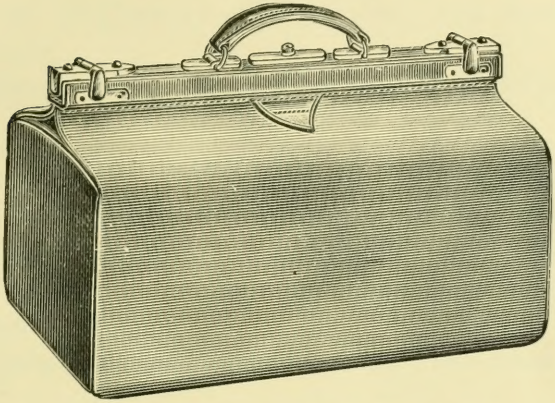

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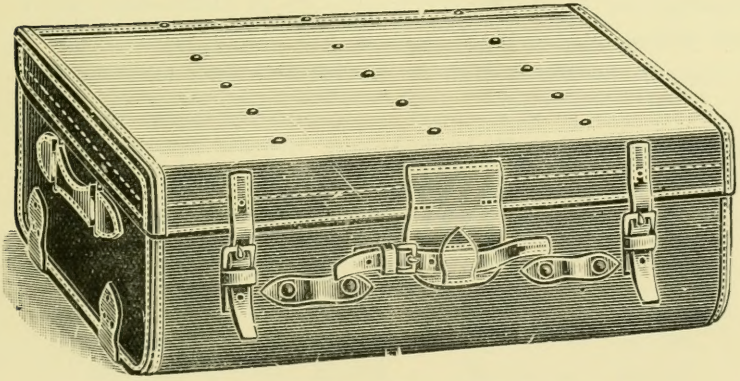

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The Scottish Botanical Review

No. 3] 1912 [July

The Geological Relations of Stable and Migratory Plant Formations. By C. B. Crampton, M.B., C.M., of H.M. Geological Survey.

(*Continued from p.* 79.)

Part V. The Geological Relations of the Migratory Plant Formations.

The great pile of sediments, dating from the Precambrian onwards, stands witness that erosion and deposition have prevailed throughout geological time. Stratigraphy has fully borne out Lyell's dictum, that the geological workings of the past are to be measured by a study of those now in operation, and, for the purposes of the present argument, we may safely assume that the physiography of past epochs was governed by statical and dynamical factors approximately similar to the present ones.

Sea-cliffs have always evolved at exposed points of the sea's margin. Beaches have formed along the line of shore-drift from places where cliff erosion afforded sufficient durable material to be pounded into shingle by the waves, but temporarily resist further dispersal. Sand has constantly accumulated in the shallower bays of exposed coast-lines, where the coastal currents slackened, and the sand, driven shoreward by the waves, has undergone exposure between tide-marks, to be captured by the winds, and built into

coastal and travelling dunes. Mud-flats have always appeared in the protected estuaries of the larger rivers, or behind sand-bars in deltas, or shingle-spits traversing shallow bays where small streams find exit seaward.

These various coastal formations have repeatedly evolved under certain recurring conditions of physiography, the results of the action and reaction of the static and dynamic factors of geology, and, apart from the effects of differences of climate and geography on plant growth and distribution, have, further, led to a similar range of habitats for the evolution of plant adaptation and association.

With the same reservations the other agents of erosion and deposition have as constantly originated defined series of habitats for plant evolution the world over and throughout geological history.

The streams have ceaselessly cut gorges and waterfalls, and laid down alluvial deposits of gravels, sands, and silty loams. So long as mountains have arisen, and passed away under the influence of erosion, so long have frost, insolation, and gravity conspired to produce alpine crags, screes, and landslips.

But the sphere of these operations has undergone endless change. The geological agents desert their work barely begun, or but half accomplished, and start afresh elsewhere, only to return once again, after intervals measured by days, years, or centuries.

From the very nature of their operations, these agents must have caused frequent disturbances in the more stable types of vegetation, whose character of stability, indeed, depends upon their absence. But other types, adapted to profit by less stable conditions of existence, or quicker to migrate and take possession of newly formed surfaces, have been ever ready to escape the biological or physical struggle for existence intensified in the areas of least disturbance, and thus have arisen plants and plant communities especially accommodated to the comparatively rapid changes of environment attached to such conditions.

With a climate favourable for vigorous vegetation, the plants that follow the track of the migratory agents include many that are forced to avoid the intense biological com-

petition of a mature succession, while in semi-desert conditions of drought or intense cold, the plants following these tracks frequently thereby escape physical extremes.

The migratory agents originate habitats with, on the one hand, a surplus, or, on the other, a reduction of water, oxygen, and salts, over that available by the neighbouring stable vegetation. They may cause excessive transpiration, as in areas of blown sand or hinder absorption, as in salt-marshes ; they may palliate extreme conditions, as in deserts and arctic regions, and generally tend to delay the type of stabilisation under the climatic conditions prevailing. Mountains, seas, and large rivers may form barriers to the spread of certain stable types of vegetation, but the alpine, coast and river belts have always preserved open routes of migration and places of refuge for plants ousted from the neighbouring areas of competition. They form sanctuaries for relic associations, or outposts for pioneer invading species.

These open ways and asylums may shelter plants that have lagged behind or degenerated in competitive stabilisation, preferring the easy existence of being continuously bathed in water, or of annually happening on fresh open formations. But the stations of the migratory formations in many cases are peculiar to the agents of surface change, and are occupied by endemic forms which have adopted lines of specialisation meeting the physical conditions of a peculiar environment, rather than those adapting them for competition over wide areas of stable topography. They have become nailed to a special physical environment, or have been forced to be constantly accommodating themselves to unstable and changing surroundings. Thus we have lithophytes, aquatics, sand-dune, swamp and marsh plants, halophytes and various xerophytes, vagrants and annuals, excluded from the neighbouring stable formations.

Some survive or even flourish under rapid physical changes in the habitat, and many have specialised in their mode of growth, and in the nature of their fruits or seeds, particularly adjusting them for dispersal by the sea or rivers, by the wind, or by migratory animals. Many have doubtless evolved under the migratory conditions in which we find them, while others may be descendants of plants that had

found refuge in stable areas, subject to climatic extremes, as drought or great humidity accompanied by low temperatures, but with amelioration of climate were liable to extinction by competition, unless they underwent changes rendering them more capable of rapid migration.

Migratory formations do not, however, always show a complete change of species from the neighbouring stable formations, but may be partly stamped by a change in the type of growth, *i.e.* the habit of certain species, or perhaps by forms or variations, such as have not yet been sufficiently explained as fixed and inherited, as purely physiological and anatomical adaptations, or selected mutations. It seems, in fact, to be the rule rather than the exception that a species common in a stable formation, on appearing as a dominant in a neighbouring migratory formation, is under a different form, which is retained everywhere within the limits of the migratory formation. This, at least, appears to hold with *Calluna vulgaris*, species of *Sphagnum*, grasses, and some other plants.

The migratory formations are naturally distributed in the field into :—

1. Those of the coastal belt.
2. Those of the stream belt.
3. Those of the foci where the physiography curtails vegetation and prevents stabilisation, owing to its influence on drought, wind exposure, low temperatures, or the instability of surface incurred through gravitation.

In the coastal belt we find various formations depending chiefly upon reactions between the following geological factors :—

1. The nature of the rocks, and the initial topography of the surface entering the belt of erosion. The resulting configuration of the coast-line and coastal profile. Their comparative permanence or tendency to rapid alteration.
2. Recent positive or negative displacements of the coast-line and their influence on plant succession.
3. The submarine profile as influencing the fetch of the waves, and thereby, in particular, the range and character of the cliff vegetation.
4. The nature of the coastal currents in their influence on

the distribution of deposits, localising the shingle beach, sand-dune, salt-marsh, and marine algal vegetation.

5. The range of the tide in its influence on the marine algal zones and the salt-marsh vegetation.

6. The position of the river exits, as affecting the salinity of the waters, and the relations of river-borne and tidal deposits, of brackish and salt-water marsh and reed-swamp.

7. The influence of seaward drainage, weathering, and gravity on the coastal profile. The ratio of degradation by weathering to the advance of sea erosion.

In the stream belt the principal factors are perhaps included in :—

1. The sources of the permanent water supply ; their nature and capacity, their distribution and seasonal variation.

2. The physiography resulting from the interaction of the drainage system and the surface, in the various segments of the torrent, valley, and plain tracts. The rate of flow, prevalence of erosion or deposition, sorting or silting, flushing or sustained submergence.

The blown sand and salt-marsh formations of the coastal belt are described in the "Types of British Vegetation" (3), and our shingle beaches are at present undergoing careful analysis (38). The stream belt, apart from the fens (3) (25), certain lakes (39) (40), and moorland districts in Scotland (26), has at present received little attention in this country, owing partly, no doubt, to the extensive artificial alterations it has undergone. Our rock formations have also received some attention (3) (26).

Many of these migratory formations, though perhaps not recognised as such, have been described by plant ecologists in various parts of the world.

Rock formations have formed a special study in Switzerland. The stream belt and coastal belt have been studied in America, New Zealand, Belgium, the Faröes, Denmark, and elsewhere.

In the following generalisations, the migratory formations are treated chiefly from the geological standpoint, as much work is needed before an ecological classification of migratory formations can be considered as placed on firm foundations. The majority of them are perhaps included under Warming's

aquatic, helophytic, lithophytic, psychrophytic, psammophytic, oxylophytic, and rubble formations, etc. (13), but the desirability of further analysing them from the standpoint of physiography has doubtless been apparent to some ecologists for a considerable period of time. Aquatic formations always vary with the physiography. Rock formations may support certain common species over wide areas of different physiography, but the majority show signs of being distinct in type and association with the physiographic factors leading to the rock exposure. Shingle beaches and alpine screes must obviously be separated, as habitats for plant life, and the meadows, marshes, and swamps of the higher and lower parts of the drainage system come under very different physiographic conditions of existence, and vary widely in their plant associations.

Certain types of plant association only follow in the wake of the migratory agents of surface change ; thus we have various spring, flush, marsh, aquatic, alluvial—meadow and swamp associations, confined within the sphere of action of the drainage system of the streams, rivers, lakes, and seas, the world over. Halophile associations are confined to the maritime coastal belt or to places marking the present or late foci of centripetal, inland drainage. The latter may form zones around inland seas or lakes, or appear in the form of playas, dry lakes, and salt marshes. Alkali soils have a somewhat wider distribution than recent foci of centripetal drainage, especially in the desert areas subject to much erosion, as the salts are redistributed by the winds, and old salt deposits are frequently re-exposed at the surface. Hilgard has shown how the salts tend to accumulate at or near the surface of the soil in sandy, saline deserts, by the effects of evaporation bringing a considerable amount of the soil water to the surface.

All spring associations have certain common factors in the water supply coming directly from beneath the surface of the ground and in being continuously changed, but various springs differ much in the volume and temperature of the water, the dissolved salts and gases, and other ways. These factors may completely suppress the growth of vegetation, only allow the presence of a peculiar flora, or cause an

association of species which individually grow in other habitats. Spring associations appear to be clearly demarcated by the extent of the focus within which the waters retain certain definite characters, but where the waters have a fairly large and constant volume certain species may follow the watercourses for considerable distances. Spring plant associations are most evident in the mountainous districts of this country, since the original relations of the drainage and vegetation have usually there been less interfered with. High level springs with *Philonotis*, *Epilobium alpinum*, *Saxifraga stellaris* (3) (p. 326), etc., can be distinguished from springs in the moorland bogs with *Hypnum revolvens*, *Sphagnum*, *Stellaria uliginosa*, etc., and these again from springs arising on the lower alluvial terraces with *Hypnum cuspidatum* and others; but various stages can often be recognised leading from one to the other, while some show peculiarities of their own demonstrating that the plants are highly susceptible to conditions which vary at different springs, and which, as yet, have received practically no attention by plant ecologists. Groups of species, including one or another of the above, or of the following (*Dicranella squarrosa*, *Hypnum sarmentosum*, *Hypnum stramineum*, *Hypnum scorpioides*, *Hypnum commutatum*, *Amblystegium filicinum*, *Mnium punctatum*, *Bryum alpinum*, *B. pallens*, *B. Duvalii*, *Webera albicans*, and species of *Aneura*, *Scapania*, and *Sphagnum*, *Selaginella*, *Montia*, *Ranunculus*, *Myosotis*, *Chrysosplenium*, and others), are commonly met with in our moorland districts again and again in precisely similar surroundings, which are often difficult to define and need careful examination. In other words, the fact that the plants are aquatic or semi-aquatic, and that the water is flowing, will not define a spring association, but rather the *tout ensemble* of conditions as included in the physiography, not only in its direct physical influence, but also in its influence on the country's fauna, whether this be as a home, death trap, barrier, or an invitation to drink. There is often a striking physiognomy in the floating carpet associations of gentle but constant springs, the mosses, hepatics, and phanerogams alike assuming a close-pressed, fastigiate growth, that is presumably to be explained as the result of

an abundant water supply and the absence of disturbing factors to phototaxis. This is specially noticeable in species of the subdivision *Calliergon* of the genus *Hypnum* in some other mosses and hepatics, and in *Montia fontana* and *Stellaria uliginosa*.

Shallow channels leading from springs and others occupied by the surface run-off of water in wet weather may be entirely carpeted with vegetation, from the velocity of the current and mobility of sand or stones being insufficient to prevent a closed plant carpet. Such channels have been termed "Flushes" by the writer, who has made a preliminary attempt at classifying those encountered in the moorland, as permanently wet (wet flushes), or periodically wet and dry (dry flushes), and also as acid, and calcareous flushes, according to the conditions of the waters (26).

Further field examination of plant habitats that have ecological relations to flushing by water reveals the fact that flushed surfaces should be primarily subdivided into two groups :—(1) hard rock surfaces, and (2) surfaces capable of easy erosion by running water. The former may be completely clothed with vegetation, though subject to torrential action, as may often be seen in waterfalls, where the whole rock face may be clothed with a special vegetation of mosses and algæ. Rock surfaces with a comparatively constant but gentle trickling stream of water, and especially if vertical or nearly so, usually support an algal vegetation only, while others, only periodically flushed, form the stations of very defined associations of bryophytes and algæ, varying from open to closed formations, and these again to open formations, with the results of progression and retrogression or reinitiation of plant succession induced by an increasing erosive power of the water as soil accumulates, and its tendency to migrate from point to point, deserting one part of the rock surface for another. The various stages of migration of a "rock flush" are marked by different plant association, but the presence of certain algæ and bryophytes, and the absence of lichens, except species of *Verrucaria*, etc., appears to specially characterise rock surfaces subject to flushing, as distinct from others only receiving atmospheric moisture.

We must therefore distinguish "rock flushes" as a group

requiring separation from other rock habitats and from the moorland and woodland flushes, etc., on soils capable of easy erosion.

The moorland flushes show relations to spring associations on the one hand, and to the grassland of the sandy river alluvia on the other, and many so-called bog plants are practically confined to these flushes and the alluvial stretches. The flushes form a connecting link and a route of migration between the springs and the grassland and swamps of the higher stream alluvia. On the slopes of some of our mountains the flushes are so numerous and so constantly migrating from one point to another, that large areas of grassland are formed through their influence, as mentioned above.

The flushes arising from snow lie have well-defined characters of their own, as pointed out in the last number of this Review (41).

Flushes are also encountered in woods, where they show a complete change in the plant association, including the trees. In this country the wet flushes in woods are commonly dominated by ash trees in oak woods and by alders in birch woods. The most frequent trees in flushes are the ash, alder, various forms of sallow and bird-cherry, and sometimes hawthorn, blackthorn, or hazel, but many flushes form open gaps in the woods occupied by what might be termed a spring-marsh vegetation. These woodland flushes are recruited from spring associations and from the bush swamps of the river alluvia.

Not only has each type of river its natural history, but so has each segment of its course. The source in a snow patch, spring, or tarn, or from water-logged peat, affects in different ways the upper drainage waters and the plant associations. In their middle courses rivers form rock-chasms and waterfalls; but again there are differences in plant association, from differences in the nature of the waters or the rocky stream channel. The submerged and amphibious associations of the waterfalls, rocky gorges and boulders, always show a close zonation, depending upon the force and erosive power of the stream, the aeration of the water, the amount of light, the depth and permanence of the stream,

and the range of spray. This may be well studied in the aquatic and semi-aquatic bryophytes and algæ of our own moorland streams.

The plants which colonise the deserted banks and crags are, further, always the same under the same physiographic conditions of exposure and substratum, and differ from the surrounding more completely stabilised vegetation.

The segments undergoing erosion slowly migrate upstream, alternating with alluvial stretches laid down on temporary base levels, where lateral erosion has prevailed over vertical cutting. The alluvial deposits of such temporary base levels are chiefly composed of sands and gravels, or torn and washed-down sods, or undermined and subsided masses of peat or soil interwoven with roots. These various forms of alluvial deposits soon become colonised by plant associations differing completely from the surrounding vegetation.

Parts which temporarily escape renewed erosion, form caps to a succession of terraces, as vertical cutting is renewed. So long as they remain subject to flooding, or differ in their physiographic relations to moisture, plant food, etc., from the neighbouring stable areas, so long will they bear characteristic plant associations, and meadow, marsh, bush, swamp, or other associations hold the ground, but with time the climatic soil-relations are restored and the ground is invaded by the associations of the dominant stable formations (26).

The lakes which are interposed in the stream belt form rather more permanent base levels to erosion, and the vegetation of their waters and shores differs considerably from that in, or flanking running water. The plankton is, of course, more abundant, and probably varies much with the nature of the drainage basin of the entering streams, and with the physiography of the lake, as affecting the food supply, the depth, temperature, and other conditions of the water. The floating and submerged aquatic flora differs much from that of running streams, and varies greatly in the high-level tarns and moorland and lowland lakes (39), (40). The marginal plant associations further differ, according to the rise and fall of the waters, the amount of incoming silt, sand, or gravel, and other factors which require investigation.

In their lower courses rivers form wide alluvial plains of loams or silts, subject to flooding at seasons depending upon peculiarities in the environment of the river basins. Where the rivers become icebound in winter, the flooding in spring is accompanied by ice rafts, effectually preventing tree growth (13). Or the flooding may be due to the melting of the snows in early summer, or to autumnal rains. Unlike the subalpine alluvial terraces, the lowland flood plains remain subject to flooding for comparatively long periods, and owing to the sluggish nature of the widespread current are apt to accumulate silt over those parts nearest the river channel These consequently become raised as natural embankments, hindering drainage from the lower marginal parts of the alluvial flats, which form swamps or marshes. The rivers also cut laterally and form oxbow windings, which, in course of time, often become deserted by the river waters, owing to short-circuiting of the main stream by further erosion. The deserted oxbows then often form natural ponds, and where beyond the sphere of the river floods, become filled up only through the growth and decay of vegetation and accumulation of humus.

Unfortunately for British plant ecologists, the natural vegetation of the alluvial flood plains of our own rivers has been largely replaced by cultivation and artificially treated pasture. Our rivers are tamed and managed and only occasionally get beyond control. The banks are artificially raised, the oxbow windings are replaced by cut canals, and the formerly flooded tracts have been drained by pumping. The natural head and rise and fall of the waters has also been altered by drainage at their sources, and erosion is minimised by breakwaters, locks, floodgates, and mill-dams.

Lately formed alluvial deposits generally have a greater surface soil fertility than the areas occupied by stable formations. This is due to their filtering action on the soluble salts or silts supplied by the river waters. The climatic effects of leaching of the surface layers of the soil, which is so marked a factor in our stable formations, is of little consequence in alluvial soils until they have been for some time deserted by the river waters. This surface soil fertility favours surface rooting species, and especially grasses, the

main disadvantage accruing to flooded alluvial tracts being the local tendency to stagnation and soil acidity. Their physical relations to drainage are moreover detrimental to deep root oxygenation, and the tree growth is generally of short stature in temperate regions and confined to certain species (13).

When the deposits are well supplied with ground water, but porous and superficially well aerated, meadow prevails in temperate climates ; where less permeable and ill-drained, marsh-land or swamp. The type of meadow naturally varies with the physiography and the nature of the waters. In the moorland region of this country a subxerophytic type of grassland is commonly met with, but our lowland mesophytic meadows have nearly all been much altered through drainage and cultivation. Extensive natural mesophytic meadows are said to still persist in Northern Russia and Asia, and form the habitat of some of the most striking species of herbaceous Umbelliferæ (1).

Reed-swamp is generally confined to a narrow fringing reed belt in our rivers, owing, no doubt, partly to artificial restrictions to the lower river courses, but extensive reed-swamps are widely distributed, according to Warming, and consist of such genera as *Phragmites*, *Glyceria*, *Cyperus*, *Typha*, and *Sagittaria*, and in tropical countries, of species of *Caladium*, *Heliconia*, *Crinum*, and others (13). Alder swamps and sallow swamps, according to the same authority, are universal in north temperate regions. And there, also, sallows and poplars fringe the streams in the steppes, while thorn forest forms a characteristic belt to those of desert subtropical zones. Black-gum swamps with *Nyssa* and *Taxodium* have been specially studied in the forest regions of the United States, and show peculiar conditions of the lower parts of the trunks and of the roots of the trees, the latter having a striking resemblance to the knee-roots of the mangroves of the coastal swamps.

In tropical countries, forest swamps of various species of palms, bamboos, and aroids have been described. According to Schimper, "Kurz states that swamp forest is the most curious forest in Burma, and of great interest to the botanist. In fact, its constituent plants are so dissimilar to those of the

surrounding forests that one must necessarily ask how all these trees come here. The greater part of them do not occur anywhere but in swamps or similar watery places. Swamp forest is completely bare in the rainy season, and it occurs in typical form in places, which in the rainy season are covered by water up to 4–5 feet (sometimes even 7 feet). It consists, like rain-forest, of several tiers: tall trees 60–70 feet high, small trees, shrubs, and plants clothing the ground" (1).

Alder and sallow swamps are widely distributed in this country, and patches of fenland still characterise some of our lower river courses. The fenland growth is apparently dependent on certain topographic factors regulating the water level and protecting the area from erosion and silt. For its full development fenland may have somewhat similar climatic requirements as the moorland, but owing to its developmental relations to physiography, is probably capable of forming far beyond the moorland climatic province. The physiographic relations of the swamps, fen and the woodlands known as "Carr," which are found in our principal fen district of East Norfolk, are set forth in the "Types of British Vegetation," to which the reader should refer.

Within the tidal way of our rivers, the reed belt generally consists of different species to those found further up stream. Fringing belts of *Scirpus lacustris*, *Sparganium ramosum*, *Heleocharis palustris*, *Carex aquatilis*, and others, with backwaters and swamps of *Typha*, *Alisma*, *Phalaris*, etc., give place to such species as *Scirpus maritimus*, *Carex salina*, *Scirpus triqueter*, and others (39). Alluvial meadows with *Poa*, *Dactylis*, *Holcus*, *Aira cæspitosa*, etc., to others with *Hordeum maritimum*, *Bromus mollis* var. *glabrescens*, or maritime forms of *Phlœum pratense*, *Agrostis*, and *Triticum*. Marshes with *Juncus effusus*, *Juncus acutiflorus*, *Iris Pseudacorus*, *Alopecurus geniculatus*, etc., are represented by others with *Juncus Gerardi*, *J. maritimus* or *J. balticus*, *Plantago maritima*, *Triglochin maritimum*, etc., and from this we pass seaward to the salt-marshes of the estuarine mud-flats covered by the high spring tides.

These have a close physiographic relation to those parts of the coast-line where the rivers deliver their burden of sands

and silts. Mud-flats occur where the delivery of silt by the rivers is greater than the marine currents can dispose of or where the physiography prevents its dispersal. Mud accumulates in the protected estuaries of big rivers where the coast-line is indented and behind sand-bars or shingle spits in the rather more exposed positions, the barrier in such cases forming the forefront of a delta, or extending across the mouths of bays where smaller rivers debouch. Through changes in the position of the barriers, the areas forming such bays have sometimes been alternately occupied by the sea with mud-flats and salt-marshes, and by brackish and fresh water, marsh, reed-swamp, and fen, fully demonstrating the migratory and unstable nature of such plant formations.

Parts of what were originally extensive marshes bordering on exposed coast-lines, like the Romney Marsh and Pevensey Levels in the south of England, are at present somewhat lower than the high-water mark of spring tides, but are protected from the sea by a barrier of shingle extending across the coastal margin of the marsh. The history of the evolution of the Pevensey Levels has been much obscured through the prolonged interference by man, but from the evidence of borings (42), and from that of the submerged forests exposed at low water along the coasts, there is some reason for thinking that the areas of these levels, during one stage of post-glacial time, were largely covered by forest, the sea level being then lower than at present. With a gradual advance of the sea and, perhaps, a deterioration of climate marking a phase of moorland extension, the forest seems to have been locally swamped and buried in fenland peat, a great part of the area at length becoming submerged by the sea and covered with sand and silts. It would be at about this time, no doubt, that the great shingle accumulation of "The Crumbles," near Eastbourne, with its numerous parallel "fulls" or ridges and hollows, began to form, and a bank of this shingle probably prevented the sea from entering the smaller Bourne Level, which is separated from the Pevensey Level by a ridge of higher ground. Pevensey is supposed to have still been reached by the sea in historic times, and previous to, and since that time, the Pevensey Level must have been successively mud-flats, salt-marsh, and

reed-swamp, the while the gradual eastward extension of a spit of shingle from the "Crumbles," further and further, embayed the silts brought down by the streams, and turned the exit of the drainage further and further to the east. The greater elevation of the most recently formed fulls may point to a slight rise in sea-level since the marshes were reclaimed, but the levels have in all probability recently subsided over wide areas owing to artificial drainage and interference with the rivers at their head waters and points of exit seaward. Salt water still percolates through the shingle barrier at high water and affects the plant association in the adjoining marsh ditches.

Apart from areas of wind erosion, sand only accumulates at temporary base levels in the swifter courses of streams, in lakes entered by such streams, and in bays or near river exits on exposed coast-lines. The plant associations which take possession of the sand depend partly on its mineral composition and humus content, but chiefly on its physiographic relations to flooding or water-level, the fairly constant or rapid rise and fall of the latter, and the nature of the water, stagnant or otherwise. Plant associations on sand alluvia may vary, according to these conditions, from open formations to grassland or heath, from marsh to bush swamp.

Accumulating sand is subject to wind drift and dune formation, but this only occurs to any extent in this country in connection with lakes and the sea coast. The plant associations following such blown sand are of an entirely different nature to the stable vegetation on sands in this climate. The former are specialised for obtaining their water supply at a depth and for resisting sand erosion and overcoming sand burial (43), whereas the latter are plants that can live on superficially leached soils subject to periods of drought and with a limited tendency to accumulate acid humus.

Flood gravels and shingle beaches are peculiar to the swifter reaches of rivers and to sea coasts. Those of recent accumulation rarely shelter any vegetation, but where less liable to frequent movement they are generally covered with species of encrusting lichens capable of growing on very smooth, hard surfaces subject to periods of drought and

insolation. The lower layers of shingle are usually moist, like the crevices of rock, owing perhaps to protection from evaporation.[1] Shingle banks in rivers often support a very varied open association of mixed annuals and perennials, vagrants and colonists from neighbouring associations. Such open associations may show a mixture of plants with very different requirements for water, which is often abundant at a short distance beneath the surface. The older river shingles in moist, exposed moorland districts accumulate acid humus owing to the growth of certain species of mosses in the crevices exposed to light, but in the more sheltered and warmer positions they frequently become occupied by thorn scrub, including species of rose, sloe, whins, and brambles, with often honeysuckle, elder, broom, and others.

In the upper courses of many of our moorland streams the alluvia often consist of great stretches of shingle due to the erosion and sorting by the stream of drift full of boulders and stones of various dimensions. These shingles remain barren if the materials are well assorted, and consequently mobile during conditions of flood, but where many boulders occur the intervening hollows are often filled with fine gravel and sand, and the part of the bed which is deserted when the stream is low forms a scattered open formation of lithophytes on the boulders and sand-dwellers in the hollows. These are chiefly plants that can withstand flooding and some amount of scour, such as *Rhacomitrium aciculare* on the boulders, and species of *Sagina*, *Bryum*, *Polytrichum*, etc., in the hollows. It is on these shingle stretches, moreover, that certain alpines, especially those which frequent springs or flushed ground, such as *Epilobium alpinum*, *Saxifraga stellaris*, and *Alchemilla alpina*, may often be found several miles from the sources of the streams where their centres of distribution occur.

Shingle stretches of this nature naturally never become grassland by any kind of plant succession, except at the tails of the banks, which often consist largely of sand, or in old deserted river loops which have become choked with fine

[1] See, however, "The Shingle Beach as a Plant Habitat," by F. W. Oliver, "The New Phytologist," vol. xi. No. 3, March 1912, p. 98, where the water problem of shingle beaches is discussed, and where the suggestion is made that it may depend upon the formation of internal dew.

debris. Grassland is, however, frequently built up on moorland shingle stretches by the dumping of sods carried down stream. Such sods usually consist of the resistant upper layers of peat, matted with roots, but the original peat flora always dies off when subjected to this treatment, and gives place to *Carex Goodenovii*, *Nardus stricta*, or other species. The sods gradually accumulate until a somewhat uneven surface becomes covered with grasses, sedges, and mosses, and eventually, when deserted by ordinary floods, forms a fine pasture in which *Anthoxanthum*, *Festuca*, and *Agrostis* are prominent species.

From gravels and shingles to the wide stretches of coarse rock debris of the alpine screes and mountain plateaux might appear but a short step, so far as the nature of the surface as a habitat for plants is concerned. The material which forms this debris has not, however, been through the mill of picking for wear and tear that has eliminated all softer material in the former case. The material is angular, formed by frost, and subject to further splitting and reduction by the same agent. The surfaces, though rougher than the pebbles, are less permanent as a basis for lichens, and are further subject to frequent abrasion from slipping or sand blast. Where long undisturbed, on the flatter summits, lichen growth is, however, rapid on account of the brief spells of drought, and may extend to the foliaceous and fruticose types of development.

The barrenness of screes and mountain top debris, like that of shingles, is, no doubt, partly due to superficial drought preventing the growth of shallow-rooted perennials and especially their seedlings. It is noteworthy that the plants of shingles and porous rock debris are often such as have fruits liable to lodge near the surface owing to their size or adhesiveness preventing them from being carried deep into the debris. Small seeds would have little chance of survival on germinating. Other plants of these places have highly developed underground rhizomes or roots, with great powers of searching for water and for replacing subaerial parts which undergo destruction. The barrenness of screes is further due as much to instability inducing landslip as to the porous nature of the surface, while that of the

mountain top debris, apart from its porosity, is chiefly the result of the intense evaporation and erosion caused by wind. Scree plants are those that can find their water at a depth by means of rhizomes and can send up shoots to the light of day despite the slipping of the surface. The plants of the plateaux debris, on the other hand, depend chiefly on their powers of resisting desiccation, erosion, and bodily removal by the wind. Block screes are highly favourable for the growth of special types of lichens and bryophytes. The blocks long resist removal from the position where they come to rest, but the surfaces are exposed to the maximum of light and atmospheric precipitation and undergo slow decay, while the general surface is for long quite uninhabitable by higher plants.

Rock formations are mainly the results of stream erosion, coastal erosion, or position in relation to gravity, frost, and poverty of vegetation. They may therefore be roughly classified into : (1) Stream gorges and waterfalls, (2) Coastal cliffs and platforms, (3) Alpine crags.

All these are naturally migratory under the influence of the geological agents, their surfaces being liable to destruction, whereupon a fresh initiation of plant succession is invited (44) (3) (26).

In the case of stream gorges the type of rock vegetation furthest removed from the influence of the stream depends on the physiographic relations of the rock to the sun, wind, and frost, and its chemical and physical relations to leaching, water capacity, and drainage. The lower parts of the gorge under the influence of spray, flooding, or erosion, each have their own type of vegetation, which may further depend on the amount of light, the aeration, and the acid, neutral or alkaline nature of the water afforded by the up-stream part of the drainage basin.

The vegetation of sea-cliffs is perhaps even more complex, since the late relative displacements of sea-level and the structure of the rocks in their relation to sea erosion in forming vertical cliffs plunging directly into deep water, or more irregular cliffs with the accumulation of beach at their base, has a marked influence on the range of the vegetation and its composition (26).

In the vegetation of the cliff top, the coastal profile is often of first significance, and besides this, the influence of the chemical and physical relations of the rock forming the cliff, to leaching, water capacity, and drainage, all require attention.

Alpine crags primarily owe their features to the slow effects of frost, insolation, and gravity, but many of the crags of mountainous regions, including most of those in this country, have been further influenced by glaciation. The late glaciation has led to rock exposures in places where frost, insolation, and gravity now only conspire towards their burial, and, on the other hand, has reduced elevated summits where such agents would be most active in erosion to rounded debris-strewn contours. The foremost tendency of these agents is towards obliterating the effects of glacial erosion, eliminating the crags on gently sloping ground and at lower levels, and forwarding the development of those on the steeper contours at high elevations. In the former case, the succession of plant associations has full stabilisation as a goal in sight ; in the latter, only true migratory associations can obtain a footing. In the latter, the true alpine crags, all the associations, lithophytes or chomophytes, hold but temporary habitats liable to destruction by disruption and landslip. As in the case of all crags and steep banks, the more elevated and exposed positions forming the tops and spurs are specially liable to leaching and drought, while the lower parts of the faces and protected crannies obtain the more permanent supply of water and food solutions which descend the surfaces and crevices of the rocks. The former are leached by atmospheric precipitation, rapidly drained, and exposed to insolation and the drying influence of wind, while the latter are more protected from sun and wind, and obtain the food materials and water draining from above. This influence on plant distribution, which may be studied on any roadside wall, extends to lithophytes, chasmophytes, and chomophytes alike, but varies much with the chemical and physical relations of the rock to leaching.

In conclusion, it may be said that all rock plant associations are apt to differ according to their relations to leaching, water capacity, flushing, drainage, and exposure to the sun. Alpine

crags are specially influenced by frost, wind, mist, drip, and snow lie ; the coastal crags by erosion, salt spray, insolation, wind, and manuring by sea-fowl, and river crags by erosion, inundation, spray, and the degree of exposure to light.

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(43) For the physiographic ecology of sand-dunes see in particular Cockayne.

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Caithness Lichens. By Rev. D. Lillie, B.D.

The following is a list of lichens gathered by me in Caithness (v.c. 109). In the case of some of the rarer species which I have gathered only once or twice, I have stated the locality.

I have to thank those who have assisted me in determining the specimens. I am especially indebted to Dr. Bouly de Lesdain of Dunkerque, France, who has examined for me a

large number of specimens and has furnished me with interesting notes and sketches and dimensions of spores of a considerable number of rare or critical species.

Lichina pygmæa Ag. (Fresgoe, Reay).
„ *confinis* Ag. (frequent).
Collema flaccidum Ach.
„ *tenax* Ach. (frequent).
„ *nigrescens* Ach.
Leptogium lacerum Gray.
„ *scotinum* Fr., var. *sinuatum* Malbr.
Sphærophorus coralloides Pers.
„ *fragilis* Ach.
Bæomyces rufus DC.
„ *aeruginosus* DC. (frequent).
Stereocaulon paschale Fr., teste Bouly de Lesdain.
„ *denudatum* Fl.
Pycnothelia papillaria Duf. (rare).
Cladonia firma Nyl.
„ *pyxidata* Fr.
„ „ var. *neglecta* Fl'k.
„ „ var. *gracillima*, teste B. de Lesdain.
„ „ var. *costata*, teste B. de Lesdain.
„ *fimbriata* Fr.
„ „ *f. subulata.*
„ „ *f. dendroides.*
„ „ var. *tubæformis* Fr.
„ *fibula* Nyl.
„ *gracilis* Hoffm.
„ *cornuta* Fr.
„ *sobolifera* Nyl.
„ *degenerans* Fl.
„ „ *f. pleolepidea* Nyl. (Morven).
„ *furcata* Hoff.
„ „ var. *spinosa* Hook.
„ *racemosa* Nyl.
„ „ *f. recurva* Fl.
„ „ var. *fissa*, teste Bouly de Lesdain.
„ *pungens* Fl.
„ *crispata* Nyl.

Cladonia crispata, var. *cetrariæformis* (DC.) Nyl.
„ *squamosa* Hoffm.
„ *coccifera* Schaer.
„ *bellidiflora* Fl.
„ *digitata* Hoffm.
„ *deformis* Hoffm.
„ *macilenta* Hoffm., var. *coronata* Nyl.
„ *Floerkeana* Fr.
Cladina rangiferina Nyl.
„ „ *f. tenuis* Fl.
„ *sylvatica* Nyl.
„ *impexa* Harm., teste Bouly de Lesdain.
„ *uncialis* Nyl.
„ „ *f. adunca* Crombie.
„ *amaurocrea* Nyl.
„ „ *f. cylindrica* Schaer.
Ramalina calicaris Nyl.
„ *farinacea* Ach. (abundant).
„ *fraxinea* Ach. (frequent).
„ „ var. *ampliata* Ach.
„ *fastigiata* Ach.
„ *scopulorum* Ach. (frequent).
„ *subfarinacea* Nyl.
„ *cuspidata* Nyl. (common).
„ „ var. *tuberculosa* Oliv., t. B. de Lesdain
„ *Curnowii* Crombie.
„ *minuscula* Nyl., teste Bouly de Lesdain.
Usnea florida Ach.
„ *hirta* Hoffm.
„ *dasypoga* Nyl., var. *plicata* Nyl.
Alectoria jubata Nyl.
„ *bicolor* Nyl.
Cetraria islandica Ach. (not common).
„ *aculeata* Fr. (common, occasionally with fruit).
Platysma ulophyllum Nyl.
„ *glaucum* Nyl.
Evernia prunastri Ach.
Parmelia saxatilis Ach.
„ „ *f. furfuracea* Schaer.
„ *sulcata* Tayl.

Parmelia omphalodes Ach.
„ „ var. *panniformis* Ach.
„ *Delisei* Nyl., var. *isidiascens* Nyl.
„ *fuliginosa* Nyl.
„ „ var. *lætevirens* Nyl.
„ *lanata* Walk.
„ *tristis* Nyl.
„ *physodes* Ach.
Stictina fuliginosa Nyl.
Lobarina scrobiculata Nyl.
Lobaria pulmonaria Hoff.
Ricasolia amplissima Leight.
„ *lætevirens* Leight.
Nephromium lævigatum Nyl.
„ *parile* Nyl. (Dunbeath Strath).
„ *lusitanicum* Nyl.
Peltigera canina Hoffm.
„ *rufescens* Hoffm.
„ „ var. *prætextata* Fl.
„ *scutata* Leight.
„ *horizontalis* Hoffm.
Physcia parietina De Not.
„ „ *f. chlorina* (teste Bouly de Lesdain).
„ „ var. *aureola* Nyl.
„ *lychnea* Nyl.
„ *pulverulenta* Nyl.
„ „ *f. argyphæa* Nyl.
„ „ var. *angustata* Nyl., teste B. de Lesdain.
„ *aquila* Nyl.
„ *aquila* var. *cæsio-prumosa* Lamy, "new for Britain," teste Bouly de Lesdain, "Bulletin de la Société Botanique de France," tome lvii., p. 31 (E. Clyth).
„ *stellaris* Nyl., var. *leptalea* Nyl.
„ *tenella* Nyl.
„ *aipolia* Nyl.
„ *lithotea* Nyl.
„ *ulothrix* Nyl., var. *virella* Crombie.
Gyrophora proboscidea Ach.
„ *cylindrica* Ach. (frequent on higher hills).

Gyrophora stipitata Nyl. (B. de Lesdain), new for Britain, teste Boul. de Lesdain. (Ben-na-bad.)
„ *torrefacta* Crombie.
„ *hyperborea* Ach. (frequent).
„ *polyphylla* T. and B.
„ *flocculosa* T. and B.
„ *polyrhiza* Krb.
Pannaria brunnea Ach.
Lecanora hypnorum Ach.
„ *saxicola* Ach.
„ „ var. *diffracta* Nyl.
„ *gelida* Ach. (Camster Cairns).
„ *elegans* Ach., var. *tenuis* Ach.
„ *murorum* Ach.
„ *tegularis* Nyl.
„ *obliterans* Nyl., "nouveau pour l'Angleterre," teste B. de Lesdain, "Bull. Soc. Bot. de France," tome liv. p. 443.
„ *sympagea* Nyl.
„ *cirrochroa* Ach., teste Bouly de Lesdain.
„ *lobulata* Somm.
„ *vitellina* Ach.
„ *epixantha* Nyl., teste Bouly de Lesdain (Swiney).
„ *citrina* Ach.
„ *ferruginea* Nyl., var. *festiva* Nyl.
„ *cerina* Ach.
„ *pyracea* Nyl.
„ *luteoalba* Nyl.
„ *irrubata* Nyl.
„ *exigua* Nyl.
„ *galactina* Ach.
„ *dispersa* Nyl.
„ *subfusca* Nyl.
„ „ var. *campestris* Nyl.
„ „ var. *glabrata*, teste Bouly de Lesdain.
„ *chlarona* Nyl.
„ *albella* Ach.
„ *glaucoma* Ach.
„ *prosechoides* Nyl.
„ *sulphurea* Ach.

Lecanora orosthea Ach.
„ *conizæa* Nyl.
„ *symmictera* Nyl.
„ *polytropa* Schaer.
„ *intricata* Nyl.
„ *erysibe* Nyl., var. *cinereo-fusca* Crombie, teste Bouly de Lesdain (Lynegar).
„ *spodophæiza* Nyl., teste Bouly de Lesdain, "Bulletin de la Société Botanique de France," tome lvi. p. 170. Miss A. L. Smith in the "Reports of the Lichen Exchange Club, 1910," expressed doubt as to the correctness of this, but Dr. Bouly de Lesdain, in a recent letter, says he still thinks it correct. The only other locality is in the island of Jersey. (Maritime rocks, Forse and Sarclet.)
„ *syringea* Ach.
„ *atra* Ach.
„ *badia*, Ach.
„ *coccinea* Crombie.
„ *ventosa* Ach.
„ *tartarea* Ach.
„ „ var. *gonatodes* Ach. (with fruit!), teste Bouly de Lesdain, "Bulletin de la Société Botanique de France," tome lvii. p. 32. (Ben-na-bad.)
„ *subtartarea* Nyl.
„ *parella* Ach.
„ *cinerea* Somm.
„ (*Aspicilia*) *Lilliei*, B. de Lesdain in "Bull. Soc. Bot. France," liii. p. 515 (Ousdale).
„ *gibbosa* Nyl.
„ *subdepressa* Nyl. (Langwell).
„ *Dicksoni* Nyl.
„ *lacustris* Fr. fils.
„ *rufescens* Nyl.
„ *discreta* Nyl., teste Bouly de Lesdain (Achow).
Pertusaria monogona Nyl., teste Bouly de Lesdain (Dunnet Head).
„ *globulifera* Nyl.

Pertusaria amara Nyl. (frequent).
„ *communis* DC.
„ *dealbata* Nyl.
„ „ forma *corallina*, Crombie.
„ *pustulata* Nyl.
Lecidea coarctata Nyl.
„ *granulosa* Schaer.
„ *parasema* Ach.
„ *goniophila* Schaer.
„ *inserena* Nyl., teste Bouly de Lesdain (Scaraben).
„ *fuliginosa* Tayl.
„ *contigua* Fr.
„ „ var. *platycarpa* Fr.
„ *crustulata* Koerb., teste B. de Lesdain (Lynegar).
„ *confluens* Ach.
„ *lapicida* Ach.
„ *lithophila* Ach.
„ „ *f. ochromeliza* Nyl., teste B. de Lesdain.
„ *lactea* Fl.
„ *plana* Nyl.
„ *fuscoatra* Ach.
„ *rivulosa* Ach.
„ *griseoatra* Schaer.
„ *dilutiuscula* Nyl.
„ *instratula* Nyl., "nouveau pour l'Angleterre," teste Bouly de Lesdain, "Bull. de la Soc. Bot. de France," tome liv. (1907) p. 444. (Camster Cairns and Dirlot.)
Biatorina cæruleo-nigricans A. L. Sm.
„ *Griffithii* Mass.
„ *premnea* A. L. Sm.
„ *chalybeia* Mudd.
Bilimbia Naegelii Auzi, teste B. de Lesdain.
„ *sabuletorum* Br. and R.
Bacidea effusa Am., var. *cæsiopruinosa* Mudd, teste B. de Lesdain.
„ *arceutina* Br. and Rostr., teste B. de Lesdain.
„ *umbrina* Br. and Rostr.
Buellia verrucolosa Mudd.
„ *stellulata* Mudd.

Buellia disciformis Mudd.
„ *coniops* Th. Fr.
„ *atrata* Mudd, teste B. de Lesdain
Rhizocarpon alboatrum Th. Fr.
„ „ forma *ambiguum* Leight.
„ *geographicum* DC.
„ *petræum* Massal.
„ *obscuratum* Massal.
„ *lotum* Sitzbrg., "nouvelle pour l'Angleterre," teste Bouly de Lesdain, "Bull. Soc. Bot. de France," tome liii. p. 517 (Ousdale).
Arthonia gregaria Koerb.
„ *radiata* Ach.
„ *paralia* Nyl., teste B. de Lesdain (Forse).
„ *varians* Nyl.
„ *Lilliei* B. de Lesd., "Bull. Soc. Bot. de France," tome lvii. p. 34 (Achastle).
Opegrapha atra Pers.
„ *vulgata* Ach., var. *siderella* Nyl.
Graphis scripta Ach.
„ *anguina* Muell. Arg.
Coriscium viride A. Zahlbr.
Dermatocarpon aquaticum A. Zahlbr.
„ *lachneum* A. L. Sm.
Verrucaria maura Wahlenb.
„ *mucosa* Wahlenb.
„ *nigrescens* Pers.
„ *Dufourii* DC.
„ *rupestris* Schrad.
„ *xanthoriæ* Wedd., *f. megaspora*, teste B. de Lesdain.
Thelidium pyrenophorum Koerb.
Thrombium lætevirens A. L. Sm. (?).
Staurothele hymenogonia A. Zahlb.
Acrocordia biformis Oliv.
Arthopyrenia punctiformis Arn.
„ *fallax* Arn.
„ *litoralis* A. L. Sm., teste B. de Lesdain.
Melanotheca gelatinosa Nyl.

Linnæus' "Flora Anglica."

By G. Claridge Druce, M.A., F.L.S.

RECENTLY suggestions have been made to use the above work as a help in fixing the determination of some of the more doubtful plants in the "Species Plantarum."[1]

I feel strongly that few advantages can result from such a course, and that its adoption might lead to greater confusion than even now prevails in some instances with the aggregate species of Linnæus.

Let us consider what the "Flora Anglica" is. Linnæus himself had but the most general idea of the British flora, his knowledge being almost entirely second-hand, and he had not the opportunity of seeing any large number of its dried plants. Therefore, when he attempted to put his binomials to the plants enumerated in Dillenius' edition of Ray's "Synopsis" of 1724, he could have had little or no critical knowledge of the plants in it. As to those species which were common in Europe and to which the synonyms or names of the Bauhins, etc., were attached, he could surmise their names with some degree of accuracy; but when he attempted to name the new plants inserted in this edition by Dillenius he often made the most appalling errors, not only of species, but even of genera and natural orders.

Had nothing else been wanting as evidence of the untrustworthiness of this work, the list "Dubia," at its end, would be amply sufficient to demonstrate it; no fewer than 120 plants, many of these good species, are included which Linnæus failed to identify, and this in itself would appear sufficient reason to prevent the "Flora Anglica" being worth serious consideration. But this is by no means the whole of the case. Most readers of the "Flora Anglica" would believe, from the list of "Dubia" being given, that these and the named plants in it exhausted all the plants of the "Synopsis," but this is by no means the case. There are besides over three hundred

[1] I thoroughly recognise the difficulty of refusing (if indeed there is a necessity) to recognise the "Centuria" and "Flora Anglica" as a valid publication of new specific names, but what I deprecate is the idea of using either work to limit or even elucidate the species in the first edition of the "Species Plantarum" when no essential change has been made in the second edition of the same work.

plants unidentified or even alluded to by Linnæus. Many of these, it is true (as of those given in the "Flora"), are forms and varieties, and several are aliens, but there are many of his own species which it is surprising that Linnæus did not identify, such as *Euphorbia hiberna* 312.5 (which is quoted from Dill. Hort. Elth. in the "Sp. Pl.," 462, 1753, and 662, 1762),[1] *Trifolium striatum* 432.9, *Saxifraga umbrosa* 355.3, *Linum perenne* 362.3 (which he cites in "Sp. Pl.," p. 277, 1753 and 398, 1762, from Ray's "Ang.," meaning the "Synopsis," and gives Cambridge as the habitat), *Anthericum serotinum* 374.3, see "Sp. Pl.," 294, 1753, 444, 1762, each citing the "Synopsis," *Cryptogramme crispa* 126.9, although cited from the "Synopsis" in "Sp. Pl.," 1522, *Fagopyrum* 144, *Leontodon hispidum* 126.9, *Allium Scorodoprasum* 370.6, *Juncus inflexus* 432.3, and others.

Now let us glance at the identifications which he has made. Many of the commoner and widely diffused species which Caspar Bauhin had enumerated in his "Pinax" are necessarily correct, but when we come, as I have said, to more critical species, and especially to the new plants added by Dillenius to the "Synopsis," we shall find that he breaks down in numerous instances. Without exhausting the matter, I find upwards of a hundred wrong identifications, some necessarily trivial, but others of a serious nature. Some are common alike to the "Species Plantarum" and to the "Flora Anglica," but many are restricted to the latter work. Space will not allow of the whole of these erroneous identifications being given, but the following may be mentioned. The figures of the references are taken from Clarke's reprint.

Name in "Flora Anglica."		Modern name corresponding to the name in Ray's "Synopsis."
136.2. Salicornia fruticosa	=	S. perennis Miller.

This is treated as a variety of *S. europæa* in "Sp. Pl." p. 1753. But if the "Fl. Angl." is valid, our British plant becomes *Salicornia fruticosa*. In the 2nd ed., "Sp. Pl.," it is also given as a species, but other synonyms which do not refer to our British species are added, and there is no reference to "Fl. Angl." or Ray's "Synopsis."

[1] This illustrates my case. Between the two editions of the "Sp. Pl.," and subsequently to the "Fl. Angl.," Hudson publishes his "Fl. Angl." in 1762, and Linnæus cites Hudson's name.

Name in "Flora Anglica."		Modern name corresponding to the name in Ray's "Synopsis."
H. 290.3. Callitriche autumnalis	=	C. intermedia Hoffm.
H. 281.2. Pinguicula villosa	=	P. lusitanica L.
(Also mistaken for Ray's Cornish plant in "Sp. Pl.")		
200.1. Valeriana officinalis	=	V. sambucifolia Mikan.
H. 429.9. Schœnus ferrugineus	=	S. pauciflorus Lightf.
429.5. Scirpus mucronatus	=	S. americanus Pers.
393.1. Panicum glaucum	=	Setaria viridis Beauv.
(No reference to "Fl. Angl." in either edition of "Sp. Pl.")		
398.2. Phalaris phleoides	=	Phleum pratense L. forma.
H. 394.4. Agrostis rubra	=	Gastridium lendigerum Gaud.
(Again no reference to Ray in either edition.)		
H. 407.9. Aira flexuosa	=	Poa nemoralis L.
H. 403.6. Melica nutans	=	M. uniflora Retz.
409.3. Poa pratensis	=	P. trivialis L.
409.4. Poa angustifolia	=	P. nemoralis L.
409.2. Poa trivialis	=	P. pratensis L.
395.4. Festuca marina	=	Desmazeria loliacea Nym.
(If the "Fl. Angl." is valid, this plant becomes *Desmazeria marina* L.)		
411.16. F. amethystina	=	F. pratensis Huds.
(The reference to Ray's "Syn." is omitted in ed. 2, "Sp Pl.," although Anglia is given as one of the habitats.)		
413.5. Bromus arvensis	=	Bromus hordeaceus L.
414.7. B. tectorum	=	B. racemosus L.
(In "Sp. Pl.," 1762, it is put under *B. mollis*.)		
405.1. Avena spicata	=	Avena pratensis L.
(Both editions of "Sp. Pl." give Pennsylvania as the only habitat.)		
H. 225.4. Galium parisiense	=	Galium anglicum Huds.
(Ray's "Syn." is cited in both editions of "Sp. Pl.")		
223.1. Rubia tinctorum	=	R. peregrina L.
149.6. Potamogeton serratum	=	P. densus L., in "Herb. Dill."
H. 150.13. P. marinum	=	P. pectinatum L., in "Herb. Dill."
227.2. Echium Lycopsis	=	Echium vulgare L.
284.2. Primula elatior	=	× P. variabilis Goupil.
277.4. Campanula patula	=	C. Rapunculus L.
278.1. C. Speculum	=	Legousia hybrida Del.
287.2. Verbascum phlomoides	=	V. pulverulentum L.
H. 202.1. Thesium Linophyllum	=	T. humifusum DC.
H. 161.1. Herniaria lenticulata and in "Sp. Pl."	=	quid ?
H. 161.2. H. hirsuta	=	Herniaria glabra L., var. ciliata.
154.2. Chenopodium murale	=	C. album L., var.
156.14. Salsola sedoides	=	Dondia maritima Druce.
(The name in "Fl. Angl." not referred to in "Sp. Pl.")		

Name in "Flora Anglica."		Modern name corresponding to the name in Ray's "Synopsis."
H. 219.1. Caucalis leptophylla	=	C. daucoides L.
H. 210.4. Œnanthe pimpinelloides	=	Œ. Lachenalii Gmel.
213.1. Pimpinella Saxifraga	=	P. major Huds.
H. 203.1. Statice Armeria L.	=	S. maritima Mill.
H. 362.5. Linum tenuifolium	=	L. angustifolium Huds.
371.2. Narcissus poeticus	=	N. biflorus Curtis.
374.1. Bulbocodium autumnale	=	Crocus sativus L.
(A name not referred to in "Sp. Pl.")		
H. 373.2. Scilla bifolia	=	S. Nonscripta Link and Hoffmg.
H. 375.2. Anthericum calyculata	=	Narthecium ossifragum Huds.
263.1. Convallaria Polygonatum	=	Polygonatum multiflorum All.
263.3. C. multiflora	=	P. odoratum Druce.
427.6. Juncus stygius	=	Rynchospora alba Vahl.
(Suec. given as habitat in "Sp. Pl.," ed. 2.)		
416.2. J. campestre	=	Juncoides multiflorum Druce.
H. 352.13. Frankenia pulverulenta	=	Polycarpon tetraphyllum L.
(Sussex and the reference to Ray's "Syn." given in both editions of "Sp. Pl.")		
140.1. Rumex aquaticus	=	R. Hydrolapatheum Huds.
H. 142.7. R. acutus	=	R. conglomeratus Murray.
142.9. R. persicarioides	=	R. maritimus L.
(In 2nd ed. "Sp. Pl." Virginia only is given as habitat.)		
H. 145.6. Polygonum pennsylvanicum	=	P. lapathifolium L.
345.3. Moehringia muscosa	=	Sagina apetala Ard.
H. 346.1. Elatine alsinastrum	=	?quid.
473.2 and 3. Tilia europæa	=	T. platyphylla, T. ulmifolia.
H. 471.5. Erica multiflora	=	E. vagans L.
142.9. Rumex persicarioides	=	Rumex maritimus L.
(Virginia only in "Sp. Pl." 1762.)		
H. 457.1. Arbutus alpina	=	Arctostaphylos Uva-ursi Spreng.
337.1. Cucubalus Behen	=	Silene maritima With.
(Subsequently referred to *S. amœna.*)		
H. 380.4. Arenaria saxatilis	=	A. verna L.
369.1 and 2. Sedum rupestre L.	=	S. reflexum L.
H. 349.6. Cerastium tomentosum	=	Cerastium nigrescens Edmonst. =C. arcticum Lange.
(In "Sp. Pl.," ed. 2, the habitat is given Granada.)		
H. 312.2. Euphorbia verrucosa	=	E. Characias, or if 312.3 E. Paralias L.
H. 312.5. E. segetalis	=	E. exigua L.
(The habitat in "Sp. Pl." 1762, is given as Mauritania.)		
H. 255.3. Potentilla opaca	=	P. verna L.
H. 273.1. Delphinium Consolida	=	D. Ajacis L.
233.8. Mentha gentilis	=	M. aquatica L.
H. 233.2. M. exigua	=	M. arvensis L.
286.2. Melampyrum sylvaticum	=	M. pratense L.
H.*282.2. Antirrhinum monspessulanum	=	Linaria repens Mill.
(The habitat in "Sp. Pl.," 1762, is given as Gallia.)		

Name in "Flora Anglica."		Modern name corresponding to the name in Ray's "Synopsis."
H.*282.3. A. arvense	=	L. repens Mill.
*282.6. A. hybridum	=	L. spuria Mill.
(This name not referred to in "Sp. Pl.," 1762.)		
H. 305.2. Thlaspi hirsutum	=	Lepidium Smithii Hook.
(*T. hirtum* in "Sp. Pl.," 1762, if "Fl. Ang." is valid, then the name would be *L. hirsutum* (L.).)		
H. 305.4. T. montanum	=	Thlaspi alpestre L.
H. 302.2. Cochlearia grœnlandica	=	C. alpina Don.
(Anglia not given in "Sp. Pl.," 1762.)		
H. 300.5. Cardamine bellidifolia	=	Arabis scabra All.
H. 297.1. Brassica Erucastrum	=	Diplotaxis tenuifolia DC.
359.11. Geranium molle	=	G. dissectum L.
H. 251.3. Malva parviflora	=	M. borealis Wallm. (M. pusilla With.)
H. 252.1. M. Alcea	=	M. moschata L.
321.7. Lathyrus angulatus	=	Vicia lathyroides L.
(An excellent instance of how an additional species to the "Synopsis" is madly identified. If the figures in the reprint of the "Flora Anglica" are correct, Linnæus also calls it *Vicia soloniense*.)		
320.2. Vicia dumetorum	=	V. sepium L.
(Doubtless Linnæus was misled by the synonym of C. Bauhin's "*V. maxima dumetorum*.")		
321.6. Vicia lutea	=	V. hybrida L.
321.7. Ervum soloniense	=	? V. lathyroides L.
H. 326.2. Astragalus arenarius	=	A. danicus Retz.
H. 330.16. Trifolium agrarium	=	T. procumbens L.
H. 330.17. T. procumbens	=	T. dubium Relh.
168.6. Hieracium murorum	=	H. maculatum Sm. and H. sparsifolium Lindb.
H. 165.9. Crepis tectorum	=	C. capillaris Wallr.
H. 193.1. Carduus heterophyllus	=	Cirsium britannicum Scop. = C. anglicum DC.
H. 193.2. C. helenioides	=	Cirsium heterophyllum Hill.
H. 193.3. C. acanthoides	=	Carduus tenuiflorus Curt.
178.2. Senecio viscosus	=	S. sylvaticus L.
178.3. S. montanus	=	S. sylvaticus L., var.
177.2. S. sylvaticus	=	S. erucifolius L.
H. 198.2. Centauria Jacea	=	C. nigra L.
(Not given for Anglia in "Sp. Pl." 1762.)		
180.3. Filago pyramidata	=	F. germanica L.
(Hisp. only in "Sp. Pl." 1762.)		
H. 180.4. F. montana	=	F. minima Fr.
380.16. Ophrys arachnites	=	Ophrys sphegodes Mill.
H. 424.10. Carex canescens	=	C. divulsa Stokes.
H. 423.6. C. brizoides	=	C. canescens L.
H. 417.1. C. acuta	=	C. riparia Curtis.
H. 437.3. Sparganium natans	=	S. minimum Fr.

Name in "Flora Anglica."		Modern name corresponding to the name in Ray's "Synopsis."
H. 261.1 and 2. Bryonia alba	=	B. dioica Jacq.
447.3. Salix arenaria	=	S. repens var. argentea (Sm.)
H. 447.2. S. rosmarinifolia	=	S. viminalis L.
H. 449.13. S. reticulata	=	S. herbacea L.
225.2. Valantia Aparine	=	Galium tricorne Stokes.
152.8. Atriplex maritima	=	A. laciniata L.
121.6. Acrostichum Thelypteris	=	Athyrium Filix-fœmina Roth.
119.2. Asplenium ramosum	=	A. viride Huds.

But the most cogent proof of the unimportance of this imperfect publication is the treatment Linnæus himself accords to it. He never cites it in the second edition of the "Species Plantarum," nor, indeed, refers to it. Even of the new British species described in the "Centuria" of 1755 and in the "Amœnitates" of 1759, namely, *Veronica montana*, *Hypericum Elodes*, *Trifolium medium*, *T. squamosum*, and *Vicia angustifolia*, only the two former are given in the "Sp. Pl." of 1762, and only the *Hypericum* has the habitat, "in Anglia," added. Moreover, plants which he wrongly gives in the "Flora Anglica," such as *Scilla bifolia*, *Antheri-cum calyculatum*, *Juncus stygius*, *Polygonum pennsylvanicum*, *Mœhringia muscosa*, *Centaurea Jacea*, *Filago pyramidata*, *Arenaria saxatilis*, *Cerastium tomentosum*, *Euphorbia verru-cosa*, *E. segetalis*, *Thlaspi montanum*, *Cochlearia grœnlandica*, *Brassica Erucastrum*, *Lathyrus angulatus*, *Vicia dumetorum*, among others, have in no case the habitat Anglia given for them. Beyond this, certain names which are used in the "Flora Anglica"—for example, *Senecio montana*, *Antirrhinum hybridum*, *Thlaspi hirsutum* (*T. hirtum* is cited), *Salsola sedoides*, *Festuca marina*—are not included in the "Sp. Pl." of 1762, either as species or in synonymy, nor do they appear in the "Index Kewensis."

Just a brief reference to the connection between the "Flora Anglica" of Linnæus and Hudson. Although it is quite true that there is no definite reference in Hudson's "Flora Anglica" of 1762 to the first edition of Linnæus' work of the same name, yet there are a few citations from the "Centuria" and from the "Amœnitates" which prove Hudson had consulted those works. We also find that Hudson has adopted a very large percentage of the erroneous names used by Linnæus, as will be seen by the

letter (H) which I prefixed to the names in the "Flora Anglica" of Linnæus. Of these erroneous names, however, many are also due to the first edition of the "Sp. Pl.," but there are many others, such as *Arenaria saxatilis*, *Cerastium tomentosum*, *Carex brizoides*, *Agrostis rubra*, *Potentilla opaca*, *Polygonum pennsylvanicum*, *Euphorbia verrucosa*, *E. segetalis*, *Scilla bifolia*, *Anthericum calyculatum*, *Antirrhinum arvense*, *Thlaspi hirtum*, *Cochlearia grœnlandica*, *Cardamine bellidifolia*, *Brassica Erucastrum*, *Œnanthe pimpinelloides*, *Salix rosmarinifolia*, and others, which are due to the interim works of Linnæus; thus many plants were introduced to our flora on entirely erroneous grounds, which it took many years to correct and to eliminate.

We may, therefore, with some confidence assume that Linnæus did not consider the "Flora Anglica" worthy of citation, and that he attached very little importance to it. For the various reasons I have given would it not be unwise to attempt to strain the rules of botanical nomenclature, bringing into the purview this trivial work in order to narrow the limitations of one of the aggregate species of Linnæus, such as *Ulmus campestris* or *Viola canina*, especially when the description and synonyms used in the second edition are in no way different from those used in the first edition of the "Species Plantarum"? As Mr. Britten says ("Journ. Bot. Sup.," xii. 1909), "It is absurd to suppose that Linnæus, in 1754, raised to the rank of the species plants (in 'Flora Anglica') which a year ago he had considered varieties, to which rank he again reduced them in 1762." So, too, we may safely urge a similar treatment for his specific limitations, and that the definition of *Ulmus campestris* and *Viola canina*, which in 1753 had one meaning, and again the same meaning in 1762, can be cited as having another meaning in 1754, when the particular name used by Dillenius, or the synonym he cites, is not referred to in the second edition of the "Species Plantarum." Had the synonyms, habitat, and description been altered so as to agree with the "Synopsis," the matter would be different. As I have already stated, Linnæus identified the plants of the "Synopsis" by the synonyms, without seeing the

plants to which they refer, the weakest of all methods of diagnosis.[1] What would be said of anyone attempting to identify Shaw's Barbary Plants by picking out such synonyms as one could from Morrison and other authors, without seeing the plants on which they were based? Therefore, why should the effort be made to bring into the arena of botanical citation such a trivial pamphlet as the "Flora Anglica," a proceeding which one may be sure its renowned author would have been the first to deplore?

A New Species of Pyrenochæta. By Malcolm Wilson, D.Sc., F.L.S.

THIS plant was discovered by Mr. Wm. Nowell in considerable quantity during the summer of 1911 on dead Holly leaves on Wimbledon Common, near London. In size it exceeds most of the species of Pyrenochæta, the diameter of the perithecium being about 1 mm. when the setæ are included. Numerous brown septate hyphæ pass from the base of the perithecium and penetrate the tissues of the host in all directions.

PYRENOCHÆTA ILICIS, n. sp. — Peritheciis amphigenis, sparsis, ovoideis vel subglobosis, ·3–·5 mm. diam. innato-erumpentibus, subcarbonaceis, atris, setis multis, nigris, rigidis, continuis, 200–400 μ superne vestitis; ostiolo prominulo, rotundo; basidiis filiformibus, alterne ramulosis, ramulis brevibus; sporulis cylindricis, utrinque obtusis, continuis, hyalinis, $6–7 = 1–2$ μ.

[1] This can be illustrated by his treatment of the Poas. On p. 409 of the "Synopsis" Dillenius has No. 2, "*Gramen pratense paniculatum medium*, 'Synopsis,' ii. 257 and C. B. P. The greater or middlesort of Meadow Grass. In pascuis et ad sepes." Of which he adds, "Differt etiam a sequente; quod panicula non usque adeo sparsa seu diffusa sit, quodque caules summi et folia lævia sint, cum in ille aspera nonnihil sentiantur," which as Dillenius' specimen shows is *Poa pratensis* L., yet because the "Synopsis" cites Bauhin's name (which in the "Sp. Pl." Linnæus uses for *P. trivialis*), so in the "Flora Anglica" Linnæus seizes upon Bauhin's name, and, overlooking Dillenius' note, wrongly identifies the plant of the "Synopsis" as *Poa trivialis* instead of *P. pratensis*, with the result of naming the next species No. 3 (which also contains Bauhin's name as cited in "Sp. Pl." for *P. pratensis*) as *P. pratensis* instead of, as it should be, *P. trivialis*, which Dillenius calls "The greatest Meadow Grass" and localises "In pascuis. Culmi pedales aut sesquipedales, non nihil asperi, seu in omnem partem extensa."

Hab. : In foliis dejectis Ilicis Aquifolii, Wimbledon in Britannia.

Considering the abundance of the host it is rather surprising that no record of this fungus has been previously published.

Agathosma trichocarpa, n. sp. By E. M. Holmes, F.L.S., F.B.S.E.[1]

(With One Plate.)

SINCE the publication of Harvey and Sonder's "Flora Capensis" many undescribed specimens of rutaceous plants have been detected in Cape Colony, and not a few of these have as yet remained unnamed in herbaria. The species of the genera in the Diosmeæ, in particular, are so closely allied that it is difficult in the absence of complete material to separate one species from another. The plant to which I have given the above name occurs in herbaria under a number only, as No. 5240, Schlechter, "Plantæ Afric. Austr." The specimen I received was in fruit, and was sent to me as a variety of *Buchu* used in S.E. Africa by the natives, by Mr. Stephen R. Webb, and was collected by Dr. Froembling.

On comparing it at the Kew Herbarium, a specimen identical with it, but without flowers, was found there, and subsequently a specimen of the same plant in flower was met with in the Natural History Museum at South Kensington.

Dr. F. Schinz of Zurich having paid much attention to this group of plants, I wrote to ask him if it had been described as yet, since it is not easy to keep pace with recent publications unless one is working at a group and can look up all the literature up to date. He assured me that it had not yet been described. I therefore thought it desirable to publish a description and figure of the plant, which is here given:—

Agathosma trichocarpa, n. sp.—Fruticulus erectus, ramosus, ramis erecto-patentibus, apicem versus fastigiatis, subcorymbosis; ramulis angularibus, densefoliatis, florentibus purpureo-rubris, pilis et glandulis obtectis; foliis parvis, sessilibus, lineari-lanceolatis obtusis, inferioribus longioribus reflexis, 6 mm. longis, 1–2 mm. latis supra planis vel subcanaliculatis;

[1] Read before the Botanical Society of Edinburgh.

Agathosma trichocarpa, nov sp.

E M. Holmes.

margine glanduloso-ciliatis ; glandulis pluricellaribus ; floribus in capitulis paucifloris, pedicellatis dispositis, bracteis paucis linearibus ciliatis ; calyce glabro, segmentis lanceolatis obtusis, 1·5 mm. longis, et 1 mm. latis, nervo unico, crasso, glandulis biserialibus immersis præditis, petalis albis, 4 mm., calycem superantibus, obovato-oblongis obtusis, in unguem gracillimum extenuatis ; utrinque glabris ; staminibus fertilibus quinque, antheris glandulâ apice coronatis, staminodiis infra lineari-lanceolatis pilosis, apicem versus glabris valde angustatis, apice glandulâ minimâ coronatis ; disco-cupuliformi, stylo filiformi glabro, carpellis inferne glandulosis, apicibus rostratis recurvis, pilis longis coronatis ; senimibus nigris nitidis.

Hab.: In regione occidentali, Africæ Australis, S. R. Webb, Legit Dr. Froembling, 1911.

Syn.: *Agathosma*, nov. sp., R. Schlechter, in planitie summi Mont Piquetberg, 530 m., ix. 9. 1894, No. 5240, Schlechter, "Pl. Afric. Austr."

The present species resembles *A. alpina*, Schlechter ("Journ. Bot.," 1898, p. 25), in the hairy tips of the carpels, but differs in the angular twigs, the longer pedicels of the flowers, the few-flowered umbels, the thread-like ends of the staminodes, and the glabrous style.

I am indebted to Dr. Schinz for a small specimen of a flowering twig of the plant and to Dr. A. B. Rendle, M.A., for kindly allowing me to dissect a flower of the British Museum specimen of Schlechter's plant, No. 5240.

EXPLANATION OF ILLUSTRATION.

a. Twig in fruit, natural size, received from Mr. S. R. Webb.
b. Flower cut open, received from Dr. Schinz as No. 5240 Schlechter.
c. Calyx separated, showing position of double row of immersed oil glands.
d. Showing disc and hair-tipped carpels, and glabrous style.
e. Petal.
f. Fertile stamen.
g. Staminode.
h. Fruit.
i. Seed.
The figures *b* to *h* are magnified.

The Past History of Monocotyledons, with Remarks on their Origin. By A. R. Horwood.

(With Two Plates.)

1. Introduction.

Much progress has been made during the last decade in our knowledge of the affinities of the Palæozoic fossil plants, in so much that it has now become possible to sketch out, in a more or less realistic manner, the history of the early vascular Cryptogams. Side by side with this increase in our knowledge, which is largely due to Williamson, whose work has been carried on by Scott, we have become acquainted with two other groups of an entirely unique character, which are also found in excellent preservation in the Coal-measures.

The Pteridospermeæ are at once a synthetic race, combining with a fern-like foliage and stem anatomy of cycads a fructification of the Phanerogamic type. Here, in fact, we may look for the origin of the seed-bearing plants. Most of the Palæozoic ferns formerly regarded as Marattiaceous ferns are now found to belong to a distinct group having cycado-filicinean affinities.

Another group of more decided gymnospermic type is that of the *Cordaitales*. In this extinct race we also have synthetic characters.

The stem anatomy resembles that of conifers of the Araucarian type and the leaves are reminiscent of cycads, whilst the fructification is distinctly like that of *Ginkgo*, a monotypic group represented now by the Maidenhair tree of Japan. In the Mesozoic epoch the researches of Carruthers and Seward in England, Lignier in France, and Wieland in America have made it clear that in *Bennettites* we have also another synthetic type, combining cycadean affinities—in some respects resembling, but really distinct from, *Williamsonia*—but possessing also a distinctly Angiospermic tendency. Thus the receptacle bears numerous cylindrical slender pedicellate structures which bear the seeds. Between these are the inter-seminal scales. At the periphery the distal portions of the scales form a pericarp entirely enclosing the seeds. (Pl. I. fig. 2.)

In *Bennettites gibsonianus*, a section through the micropylar end exhibits the embryo with remains of the endosperm above, the slightly bifid micropyle, and a three-layered testa. The connection between the adjacent scales and pericarp can also be clearly seen in longitudinal section. (Pl. I. fig. 1.)

The embryo was dicotylar, the radicle pointed, and situated at the micropylar end. Traces of the plumule have been detected. The exterior of the pericarp is furrowed being penetrated by the micropyles of the seeds, between which there is a network formed

by the junction of the scales uniting to form the pericarp, the micropyles lying in the angles of the furrows.

In this anomalous cycadean group we have doubtless the first beginnings of the Angiospermic stock. A long gap intervenes between it and the forms regarded as primitive amongst Angiosperms, viz. *Magnolia*, *Liriodendron*, etc., but there is much to recommend their derivation from *Bennettites*, which in turn is in the same line as the Pteridosperms. (Pl. I. fig. 3.)

We propose to see what evidence there is in the rocks as to the history of monocotyledons, and also as to their origin. This may lead us to a general origin for Angiosperms.

2. General Character of Monocotyledons.

Angiosperms are divided into two groups, monocotyledons and dicotyledons, a division based upon the number of cotyledons or seed leaves, there being only one in the former, two in the latter in the seedling, as commonly understood.

But this difference, which is not obvious except in the young state, nor always then to be observed, is not the only one. Other differences are correlated with it, and to the main distinction there are exceptions amongst dicotylar forms, where some are monocotylous.

As a general rule these other characters are :—

1. One cotyledon.
2. Scattered bundles of the stem.
3. Development of the embryo.
4. Parallel venation of the leaves.
5. Short duration of primary root.
6. Albuminous seeds.
7. Trimerous floral structure.

Some characters are due to physiological conditions of existence, depending largely upon the adaptation of the plant to its surroundings, whilst others are doubtless due to heredity.

The first three and the last appear to be largely due to heredity, whilst the others are more or less adaptive characters. And it is doubtless only because they have been longer fixed that the former may now be strictly hereditary. The latter may be homoplastic, occurring in some degree in other groups exposed to similar conditions. A feature common to a large proportion of monocotyledons, 33 per cent. as against 4 per cent. in dicotyledons, is the prevalence of the aquatic habit. With this many characters are connected and may be said to be adaptations owing to the same physiological cause.

Although there are so many aquatic monocotyledons, they are distributed over six cohorts out of ten. Amongst Palms, Cyclanthaceæ, Scitamineæ, and Orchids there are few if any aquatic forms. In dicotyledons they are mainly confined to Polygonales, Ranales, Rosales, Geraniales, Myrtifloræ, Contortæ (Gentianaceæ), and Tubifloræ. The comparative uniformity of type in monocotyledons may be attributed to their aquatic life. Whilst many forms are

aquatic, however, others are widely terrestrial, *e.g.*, grasses, sedges, etc., and others are Geophytes, Liliaceæ, etc., and some are climbing plants. The majority are fond of a moist climate. Most groups are shrub-like. A few Palms, *Pandanus*, etc., are arboreal.

3. Range in Time of Monocotyledons.

Many problematical fossil organisms have been assigned to this group of which the preservation is so imperfect, or the geological age too remote, to merit serious consideration in this connection. A few instances of noted errors of the kind may, however, be referred to at this point

The Carboniferous fossil *Pothocites*, considered to be an Angiosperm, is the fructification of a Calamite, as shown by Kidston.[1]

The fossils named *Spirangium*, found in Carboniferous and later rocks, are the egg-cases of a fossil shark. They have been assigned to a variety of different groups of plants, *e.g.*, Bromeliaceæ, Cyperaceæ, Equisetaceæ.

Aethophyllum compared with Typhaceæ is found in the same beds as *Schizoneura*, a genus of the Equisetales, and may be part of a plant of that group.

Echinostachys has also been referred to *Typha*, but on no better grounds, and may be nothing more than some form of coniferous cone such as *Voltzia*.

Starkie Gardner[2] figures fragments of the stem of a supposed monocotyledon from the Yorkshire Oolite, but they are only portions of *Equisetites beanii* (Bunb.) as pointed out by Professor Williamson. The fragments termed *Endogenites* and supposed to be monocotyledonous by Lindley and Hutton the authors of the "Fossil Flora,"[3] are only portions of cycads in the case of the Wealden specimen, whilst the Carboniferous *Endogenites striata* may be *Lyginodendron*.

A number of so-called monocotyledons were figured and described by Buckman from the Lias, but these have all been found to be either fragments of gymnospermous leaves or cryptogams.

The specimens he describes are referred to Liliifloræ, Naiadaceæ and other groups. Our earliest palæobotanists, Sternberg, Schlotheim, and others, even down to Lindley and Hutton's time (1831–1837, "Fossil Flora") regarded the Palæozoic plants *Calamites*, *Annularia*, *Calamocladus* (*Asterophyllites*), *Stigmaria*, etc., as Angiosperms. And *Calamites* was for long regarded as a fossil reed, and *Nœggerathia*, and the triquetrous seeds known as *Trigonocarpus* were referred to the palms.

Lindley and Hutton also conclude that Cactaceæ, Euphorbiaceæ, etc., existed in the Coal-measures.

[1] "Annals and Mag. Nat. Hist.," 5th ser., vol. x. p. 404, 1882; *ibid.*, 1883, p. 395.

[2] "Geol. Mag," pl. ix. fig. 3, 1886, pp. 201–2.

[3] Vol. iii., pl. 227 A, p. 193.

Even so high an authority as the late Sir J. W. Dawson,[1] who did so much for Canadian and North American fossil botany in general, was disposed, during the 'seventies, to regard certain Carboniferous fossil plants as Angiosperms, *e.g. Syringoxylon mirabile.* The beds he ascribed to the Devonian are, doubtless, as pointed out by M. Zeiller, Carboniferous.

The continued pertinacity with which two of our greatest palæobotanists and the illustrious M. Ad. Brongniart, on the one hand, regarded *Sigillaria* as a Phanerogam, and M. Renault, on the other, held the view that certain types of silicified *Calamites* were also phanerogamous, are instances of the same kind of argument, based on characters—in this case a secondary thickening of the wood—which are now found to be homoplastic, and to occur in groups of widely different affinity. The existence of the group monocotyledons, in which there is no cambial activity, ought to have been enough to warn so experienced a taxonomist as M. Brongniart.

The founding of fossil monocotyledonous genera merely upon the parallel nature of the veins is an instance of the same character. Many leaves of this type belong to other groups, *e.g.* Cordaitales or Bennettitales, and bits of Equisetaceous stems are extremely liable to be confounded with them also. Many fossil fragments, *e.g. Yuccites*, are based upon no more satisfactory material.

In effect, very few authentic examples of fossil monocotyledons are found in the rocks, and they are mainly confined to the Cretaceous and Tertiary system.[2] Any earlier records must be looked upon with suspicion, in the light of previous experience, unless based upon exceptionally well preserved material.

Most of the fossil monocotyledons hitherto described from pre-Cretaceous rocks, have been founded, in fact, upon imperfect or incomplete fragments of very doubtful affinity.

I. Pandanales.

i. *Typhaceæ.*

Many fragments of stems, leaves, or rhizomes have been referred from time to time to Typhaceæ, even to plants occurring as far back as the Bunter period, from which Brongniart named *Echinostachys oblongus*, a genus based on external characters which can in no wise be regarded as conclusive evidence, and in this case of very doubtful value.

But in the Tertiary we certainly do find stems, leaves, rhizomes, and the inflorescence of fossil plants which may be directly compared with *Typha latifolia*, of Linnæus. Thus *Typha latissima*, A. Br., from the Tertiary of Aix, which is found also in the same rocks as far

[1] "Quart. Journ. Geol. Soc.," vol. xviii. p. 305, pl. xii., fig. 145; and "Fossil Plants of the Devonian and Upper Silurian Formations," 1871, p. 64.

[2] Miss M. C. Stopes has recently found that many of these so-called Phanerogams are wrongly ascribed.

as Transylvania, in Croatia and Samland, and Unger's *Typhæoloipum maritimum*, *Zosterites kotschyi*, and *T. hæringiana*, Ett., may be possibly synonymous. What is described by Unger as *Typhæoloipum lacustre* from Hungary, as well as his *Culmites anomalus*, appear to be identical with Stur's *T. ungeri*. The recent species *Typha angustifolia*, L., and *Sparganium ramosum*, L. are found in the Tufa of Montpellier, as well as the latter in Pleistocene deposits in Britain.

ii. *Sparganiaceæ.*

Cretaceous fossils referred to *Sparganium*, e.g. *S. cretaceum*, Heer, appear to be of a very unsatisfactory nature, and so also is *S. crassum* from the Miocene of Spitzbergen, and *S. latum*, Weber, from Bonn, which has a median nerve, and has been referred by Heer to Cyperaceæ. Likewise very problematical is *S. braunii*, Heer, from Œningen, the inflorescence of which is very obscure.

Two widely distributed Tertiary species are *S. stygium*, Heer, (*S. acheronticum*, Unger), and *Sp. valdense*, Heer (= *Sp. neptuni*, Ett.) which, under the latter name, is found at Bilin. From the same locality *Sp. extinctum*, Ett., has been procured. It has an ovoid inflorescence, which may be the result of mineralisation, but in its leaves it bears great resemblance to *S. natans*, L. *Sparganium ramosum*, L., is found in Preglacial, Interglacial, late Glacial, and later beds and *S. simplex*, and *S. minimum* in Interglacial beds.

iii. *Pandanaceæ.*

The British Jurassic fossils referred to *Pandanus* (screw-pines), have been regarded as gymnospermous. Probably also the Cretaceous fossils from lower Austria, ascribed to *Pandanus*, are likewise not referable to the group Pandanaceæ, and may represent, as has been suggested, Cordaitean leaves.

Seward has shown that the Jurassic species described by Carruthers as *Kaidacarpum* are Araucarian, and *Podocarya*, distinguished by Carruthers but identified as *Kaidacarpum* by Heer, is looked upon by the same author,[1] as belonging to *Bennettites*, a cycadean genus. Even *K. cretaceum* is not above suspicion, and Schimper and Schenk suggest it may represent a stamen rather than a fruit and be referred to *Barrotia*.

According to these authors the specimens named by Visiani, *Aloites italicus* may be referred to Pandanaceæ, but Saporta thinks that both the latter and *Dracæna benstedti* remind one of *Cordaites*. Seward[2] places *Dracæna* in a fresh genus *Benstedtia*,[3] in order to mark the uncertainty as to its affinity, at the same time suggesting its cycadean connection. The superficial resemblance between

[1] "Annals of Botany," 1896, p. 207.

[2] *Ibid.* p. 218.

[3] Miss Stopes, "Geol. Mag.," 1911, p. 55, places it in Coniferæ and calls it *Coniferocaulon Benstedtii*; but Knowlton, *ibid.*, places it in *Benstedtia*, in which Seward placed it, suggesting cycadean affinities.

Pandanus and some of the Cycadales is illustrated by the suggestion made by Saporta that *Goniolina* from the Kimmeridge clay and Corallian of France (probably a siphoniaceous Alga) and *Williamsonia* (a member of the Bennettitales) should be referred to the Pandanaceæ.

II. Helobieæ.

iv. *Naiadaceæ.*

Some of the forms placed in *Naias* are not very well characterised as such, but fruits resembling those of this genus have been found at Œningen. The leaves called *N. stylosa* and *N. effugiata* by Heer are doubtful, and *N. striata* of Spitzbergen has but one instead of 2–4 styles. In the Interglacial beds four species of *Naias* are found in Britain. Now only two exist, and they are very local. Very unsatisfactory are the genera *Naiadita*, *Naiadopsis*, *Naiadonum*, *Sphenophora*, *Marimima*. *Naiadita lanceolata* is now shown to be a Lycopod, and is placed by Miss Ijerna Sollas,[1] in *Lycopodites*, after being compared with *Fontinalis*[2] as a fresh-water moss. Possibly *Marimima* is a member of the Casuarineæ.

v. *Potamogetonaceæ.*

Of fossil pond-weeds, etc., a goodly number must be relegated to other groups or to oblivion. The living forms are in general marsh or aquatic plants. The submerged and floating leaves differ so largely amongst themselves within the limits of the same species, and are fashioned so nearly upon the same plan in a number of families of different affinity that an exact determination of fossil Potamogetonaceæ or Naiadaceæ is rarely to be made.

Some fossils have been placed in *Posidonia* and in *Cymadocea*, and Brongniart instituted the genus *Caulinites* for some forms, but the latter is of such an artificial nature that it is of no value, and contains widely different plants. Some of those referred to *Posidonia* may better be placed in *Zostera*, *e.g. P. cretacea*, S. and M., Westphalia, *P. perforata*, S. and M., Eocene, Gelinden. The fossils referred to *Thalassocaris*, Debey, of the chalk of Aix-la-Chapelle, Westphalia, Maestricht, may perhaps be placed in *Posidonia*. There seems little doubt that plants allied to *Zostera* existed in Cretaceous or at least early Tertiary times forming the same submarine meadows that they do to-day. Some Tertiary fossils have been referred to *Zostera*, viz. *Zostera ungeri*, Heer, *Zosterites marinus*, Unger, Radoboj, etc. *Zostera marina*, L., is found in Neolithic beds in Sweden.

The dimorphic character of the leaves of *Potamogeton* is well-known, and consequently the distinction between species, if rightly referred to the genus, is very unlikely to be always accurate in the case of fossil genera.

[1] "Quart. Journ. Geol. Soc.," vol. lvii., 1901, pp. 307–12, pl. xiii.
[2] Gardner, "Geol. Mag.," 1886, p. 495.

The Tertiary species *Potamogeton geniculatus*, Œningen, *P. cæspitans*, Sap., Aix, seem to be satisfactory.

The present distribution of *Potamogetonaceæ* favours the occurrence of *Potamogeton*, *Posidonia*, *Zostera*, in the American Cretaceous and European Tertiary. A number of species of *Potamogeton* are to be found in Preglacial beds, and *Ruppia* is met with in Interglacial deposits.

vi. *Juncaginaceæ.*

In the Tertiary of Œningen some fossils allied to Juncagineæ are found, which Heer, basing the determination upon the fruits, which he considers related to *Scheuchzeria*, names *Laharpia umbellata*. The present distribution of *Scheuchzeria* is confined to North and Mid Europe (Arctic), North Asia, and the Rocky Mountains, and the genus is represented by one species only, *S. palustris*, L., with a creeping root-stock, slender leaves, flowers in a raceme, and fruits of 2–3 follicles. It is found in beds of late Glacial and Neolithic age in Sweden.

vii. *Alismaceæ.*

The Alismaceæ are aquatic or marsh plants. To this group several fossils of Upper Cretaceous or Tertiary age are assigned. A fossil named *Alismacites primævus*, from the Wealden of Portugal may possibly be correctly assigned. Some are compared with *Alisma*, a genus with erect leaves, whorled flowers, and erect seeds with a hooked embryo.

Such plants as those described by Heer from Atane, under the name *Alisma reticulatum*, cannot be determined. The attribution of *A. macrophyllum* to *Alisma* is doubtful, and the fossil described as *A. paucinervis* may even be dicotyledonous. The former is a Spitzbergen species, the latter from Greenland, which demonstrates the former wide Northern distribution of the genus, now common to the Temperate and Tropical zones. All of these fossils are based upon leaves, and in a fossil condition there cannot be much to distinguish the leaf of an *Alisma* from that of a *Potamogeton*. Indeed *A. lancifolium* of the Eocene may belong to the latter. *Alisma plantago*, L., occurs in Preglacial beds in Britain.

Sagittaria is another genus of similar habit and much the same type of inflorescence as *Alisma*, from which it differs in being unisexual. The fossil from Alaska, described by Heer as *Sagittaria pulchella*, is quite likely to belong to *Potamogeton* or *Alisma*. The fossils founded on characters of the fruits, which in the recent genus resemble those of *Alisma*, viz. *S. difficilis*, *S. hyperborea*, described by Heer from the Tertiary of Spitzbergen are exceedingly doubtful. The recent genus is distributed over the temperate and tropical zones.

It is found in Interglacial beds in Britain and in Neolithic beds in Sweden.

It is conceivable that many fragments of totally distinct plant

stems, leaves, or rhizomes, might be referred to *Butomus*. It is a marsh plant and is found at the present day in Europe, N.W. Asia, N.W. India, having a similar distribution to other Helobieæ.

There are two fossil species which have some claim to be included in *Butomus*. These are the Tertiary *Butomus acheronticum*, Heer, found at Œningen, and *B. heerii*, Ett., found at Bilin.

No fossils can be assigned to *Elisma* or *Damasonium*, the former is now confined to N.W. Europe, and the latter to Europe, California, Australia. They are not found in Preglacial or Glacial beds.

viii. *Hydrocharideæ*.

The Hydrocharideæ are nearly all aquatic plants with aerial floating or submerged leaves. Their distribution is confined mainly to the Tropics, but some species occur in temperate regions, and some inhabit tropical seas. There are about forty living forms. The leaves are orbicular in *Hydrocharis*, ensiform in *Stratiotes* and linear in *Elodea*, to take three dominant British types of the present day. Fossil forms have been referred to *Stratiotes*, *Hydrocharis*, *Vallisneria*, *Ottelia*. The genus *Vallisneria* is distributed at the present day over both hemispheres. It contains two species, both of which are freshwater species. *V. spiralis* is confined to Australia. It is remarkable for the curious manner in which fertilisation is effected. The male flowers are short and becoming detached float on the surface of the water, but the female is borne on a long spirally coiled stem which rises to the surface and allows the flower to float, and in time come in contact with the detached male flowers.

Vallisneria bromeliæfolia, Sap., Eocene, Aix, has leaves of a general character resembling those of the recent genus.

The fossils based on the leaf-fragments from the Jurassic of Siberia, and called *Vallisnerites jurassicus* by Heer, must be regarded as open to question.

The flower described by Heer as *Stratiotites naiadum*, from the Tertiary of Œningen, is doubtless referable to the genus *Stratiotes*.

In this genus the flowers are also submerged before flowering takes place, but they float upon the surface at the period when fertilisation is to be accomplished, and the fruit when formed again sinks.

The general inflorescence and perianth is like that of *Hydrocharis*, but the female flower is sessile and is seated on a 2-spathed peduncle. The distribution of *Stratiotes* is limited to Europe and Siberia, but it is not found in Greece.

The British species is found in ponds and ditches on the east coast, and has been met with in Preglacial and Interglacial beds in Britain.

Hydrocharis is a floating plant with entire orbicular leaves, *H. morsusranæ*, L., having reniform orbicular leaves. Heer described a species, *H. orbiculata*, which resembles the living species sufficiently in form. The fossil figured by Weber from the Tertiary of Bonn,

and called *Hydrocharites ovatus* is of doubtful affinity. The genus is found at the present day in Europe and North Asia.

Ottelia inhabits the mouths of rivers, *e.g.* the Nile, Ganges, and rivers in Australia. The leaves are cordate and the plant is practically stemless. The flowers are hermaphrodite, being situated on a scape and enclosed by a spathe. The flowers possess 6–12 stamens, and 6 stigmas. The berry contains 6–8 cells with many seeds.

Brongniart gave to a fossil from the Eocene of Paris the name of *Potamogeton multinervis*. It had oval petiolated leaves. The veins were numerous and longitudinally connected by reticulations. Saporta, however, renamed this fossil *Ottelia parisiensis*, and draws a comparison between it and *O. ulvæformis*, Pers., a native of Madagascar. Other fossils have been referred to *Ottelia* also.

The genus *Hydrilla* is closely allied to *Anacharis*. It is an aquatic plant with whorls of sessile leaves, and a slender stem. Like *Ottelia* it is found in rivers in India, China, and America. The single flowers are in axillary spathes. The perianth is reflexed and six-cleft. It possesses three stamens which become detached and float upon the water. Like *Vallisneria*, the female flower has a long threadlike stem, and the stigma thus comes to the surface and is fertilised by the male flowers. Heer describes a fossil under the name *Naias stylosa*, from the Swiss Tertiaries, which may perhaps be a *Hydrilla*.

III. Glumifloræ.

ix. *Gramineæ*.

Many fossils have been wrongly ascribed to grasses. Those familiar with Lindley and Hutton's "Fossil Flora" will recall the *Poacites cocoina*,[1] which is really part of the leaf of a species of *Cordaites*. The unsatisfactory nature of characters based on leaf-form, unless also supplemented by structural evidence, makes it practically impossible to place such fossils in existing genera.

Specimens based on spikes or flowers have been named *Oryza exasperata* by Heer, and specimens from the Tertiary of Switzerland have also been referred to *Panicum*, L., and to *Palæopyrum*, Schmalh, from the Eocene of Kiew.

Like the equisetaceous fossil plants, called *Calamites* by Suckow and originally held to be fossil reeds, many fossils have been referred to *Bambusium*, which have no true resemblance whatever to the recent *Bambusa*.

Such are *Bambusa bohemica*, Ett., and *B. miocenicum*, Ett., from Bilin., and *B. neocomense*, Heer, from the Miocene of Fribourg, is probably cycadean.

The comparatively recent *Bambusa lugdunensis*, Sap., of the Middle Pliocene, Meximieux is, however, more satisfactory, the leaf-characters recalling those of a living Asiatic species.

The Festuceæ are represented in European and North American

[1] "Fossil Flora," p. 169, vol. ii., pl. 142, B.

Tertiary beds by Heer's *Arundo gopperti*. This has a rhizome exactly like that of the recent *A. donax* (Pl. II. fig. 4). In the Cretaceous *Arundo gronlandica*, Heer, from Greenland is too fragmentary. *Arundites* is also doubtful.

Phragmites ungeri, Stur., occurs in fresh-water beds in Hungary. *P. œningensis*, Heer (Pl. II. fig. 2), is widely distributed over the Tertiary beds of Europe, the Polar tract, and North America. The Cretaceous *P. cretaceus* of Lesquereux is doubtful, as also are *Pseudophragmites provincialis*, and *P. arundinaceus* from Tertiary beds of South France. *Phragmites communis*, L., is found in the Cromer forest bed, East Anglia.

x. *Cyperaceæ.*

In the Tertiary beds of Œningen some of the fossils have been assigned to Cyperaceæ, and though most are exceedingly obscure there are some, however, in which the rhizomes, which are creeping, resemble those of the recent *Cyperus*, *e.g.* Heer's *Cyperus braunianus*. The genus now consists of some 700 species and is distributed all over the warmer portions of the globe.

In Preglacial and Interglacial beds *Cladium mariscus* and several species of *Carex* occur, as well as *Eleocharis* and many species of *Scirpus*, in addition to some *Eriophora*.

Rhizocaulon of the Parisian Eocene is regarded as belonging to the Cyperaceæ, but its affinities are uncertain.

IV. Spadicifloræ.

xi. *Palmaceæ.*

The Spadicifloræ have many representatives in rocks of various age. Fossil palm leaves are amongst the commonest fossils of the later formations and aroids are doubtless represented.

The palms and arums are graceful, lofty trees, with umbrageous foliage, either palmate or fan-shaped. The inflorescence is a spadix enclosed in a spathe. There is no perianth as in Liliifloræ. The group is characterised as far as the fruit is concerned by its large and hard seeds. Of living palms there are over 1000 species.

Flabellaria is a convenient term for several early forms which cannot be referred to or compared with the recent genera such as *Sabal*, *Phœnix*, *Elais*, etc. Amongst the species placed in this genus are fan-shaped leaves of *Fl. eocenica* from the Cretaceous of North America, also *Fl. longirachis*, Ung., and *Fl. chamæropifolia*, Göpp., which are found in the Upper Cretaceous beds of S. France, Austria, Silesia.

In the Tertiary remains of palms increase up to the Miocene, and then decrease, being still found in the South of Europe, and in the Tufa of Lipari.

In Oligocene and later times the palms reached a latitude of 54° N., *Palmacites dæmonorops*, Heer, occurring at Bovey Tracey.

In Cretaceous times palms reached as far north as Greenland, where Heer records *Fasciculites gronlandicus*. Massalongo records under the genus *Scitaminophyton*, a fossil which may be a palm from the Tertiary of Rouca. *Geonomites schimperi* described by Lesquereux from North America may be a *Chamædorea*.

Some forms may well be compared with *Sabal*, as *Bembergia pentatrias*, Caspary, and *Phœnix eichleri*, Conw., from the amber of Samland.

An inflorescence described by Crié as *Palæospathe sarthensis* from the chalk of Sarthe, a genus which includes many indeterminable species, may be compared with *Sabal* or *Phœnix* (date-palm).

Some species with palmate leaves referred to *Phœnix*, e.g. *P. aymardi*, Sap., *Phœnicites spectabilis*, Ung., and *Ph. borealis*, Friedsrich, may be placed amongst the Phœniceæ, as also *Calamopsis bredana*, Heer, of the Tertiary of Œningen. In *Latanites* we have fan-shaped leaves of the Sabal or *Chamærops* type. Both the present distribution of the Sabalaceæ and Phœniceæ is borne out by the evidence of the fossil forms.

The fossils called by Heer *Chamærops helvetica*, Heer, from the Swiss Tertiaries, are in a fair state of preservation and may be rightly referred to that genus. Likewise may *Ch. humilis*, L., Tufa of Lipari, and *Sabal major*, Ung., Oligocene and Miocene, *S. campbelli*, Lesqx., Tertiary, North America, doubtless be referred to the genera in which they have been placed.

Nipadites may furthermore include fruits of palms, though equally like those of *Pandanus*. Thus side by side with *Sabal*, *Phœnix*, other palms lived in the Tertiary of Europe, all trace of which is now obliterated by climatic and other changes.

xii. *Aroideæ*.

Many fossils having no connection with the group, or too imperfect for an exact determination, have been referred to the Araceæ. Many of the fossils referred to *Aroites* or *Aronites*, must, however, be excluded.

Aroides stutterdi, Carr., from the Stonesfield State, described as portion of the spadix of an Aroid, and compared with *Xanthostoma* by the author of the species, is regarded by Professor Seward as too unsatisfactory to determine whether it is the cast of an animal or plant.

Aroites tallyanus, Kovats, may be a conifer. The fragments described by Lesquereux, from the Tertiary of North America, as *Acorus brachystachys* are doubtful, the plant so named, also by Heer, from Spitzbergen, appears to have more claim to be referred to *Acorus*, and bears some likeness to *A. gramineus*, Ait., of Japan.

According to Conwentz the species named *Carex eximia*, by Goppert and Menge, is also an *Acorus*, and his *Acorus minor* has a cylindrical inflorescence, 20 mm. long, with spirally-arranged, pointed, cylindrical fruit.

Several fossils giving the name to a series of beds of Tertiary age are assigned to *Pistia*—a tropical aquatic plant, like *Lemna*—in North America. Of these *P. corrugata*, Lesqx., from the Point of Rocks, may rightly belong to this genus, and the fossil called *Ottelia americana*, by Lesquereux, also; whilst *Lemna scutata*, described by Dawson, appears to be a young plant, and what is regarded as a parallel nerve at the margin is perhaps a fold, the whole leaf being much compressed.

The oldest forms referred to *Pistia*, *P. mazellii*, Sap. and Mar., are from the Upper Cretaceous of Bouches-du-Rhone, near Faveau, and are allied—like *P. corrugata*—to the recent *P. stratiotes*, L. Of the fossils from the chalk of Senden, referred to this genus or allied forms, some may be cycads others dicotyledons. The fossils placed in *Pistites* and *Lemnophyllum* must be excluded according to Schenk.

xiii. *Lemnaceæ.*

Of fossil Lemnas there are few which are founded on any solid basis. From the Tertiary of Wurtemberg Probst describes a form, and Lesquereux founds a species, *Lemna penicillata*, upon material from the American Oligocene, and the genus is cited from the Miocene of Wurtemberg.

V. Farinosæ.

xv. *Eriocaulaceæ.*

The anomalous distribution of *Eriocaulon septangulare*, which is an American plant with a single European station or stations in the Hebrides, Isle of Skye, is perhaps elucidated by the occurrence in Tertiary rocks, at Sand Creek, of a fossil named *Eriocaulon* (?) *porosum*, by Leo. Lesquereux, and, as pointed out by Schimper and Schenk,[1] suggests a former connection between Europe and North America in Tertiary times, whilst the former connection between Japan and North America may be suggested by the occurrence of *Eriocaulon sexangulare* in both of those countries, but not elsewhere.

Dr. Rendle remarks upon the distribution of *E. septangulare*. "This species also occurs in Atlantic North America, and like *Naias flexilis* and *Sisyrinchium angustifolium* indicates a former closer relationship than at present obtains between the north temperate floras on the two sides of the Atlantic."[2]

xvi. *Commelinaceæ.*

Certain fossils described by Caspary with flowers with 3 sepals, 3 petals, and 6 stamens, from the amber of Samland, as *Commelinacites dichoresandroides*, may be referred provisionally to Commelinaceæ, and *Maianthemophyllum* contains species which resemble them in leaf-form.

[1] "Traité de paléophytologie," 1891, p. 355.
[2] "The Classification of Flowering Plants," vol. i., 1904, p. 274.

xvii. *Bromeliaceæ.*

Equally unsupported by fossil evidence is the existence of fossil pine apples, or Bromeliaceæ, in Tertiary beds. The fossil named *Bromelia gaudini*, by Heer, from the Tertiary of Lausanne, which he compares with the South American *Puya*, is extremely doubtful.

VI. Liliiflorae.

xix. *Juncaceæ.*

Some forms, referred to rushes or Juncaceæ, are described by Heer from the Upper Miocene of Œningen, *e.g. Juncus retractus*, *J. articularius*.

xx. *Liliaceæ.*

Several fossils, amongst Liliaceæ, have been referred to *Yucca*,[1] but all except perhaps *Y. cartieri*, Heer, Molasse d'Aar and Wangen, are doubtful.

Others have been attributed to *Dracæna*, dragon tree, but with the exception perhaps of *D. narbonensis*, Sap., Oligocene, Armissan, they are very problematic, and in some cases not monocotyledonous. The species cited may not be *Dracæna* but *Yucca*. A fossil aloe is referred to the provisional genus *Agavites*.

A few fossils have been referred to Smilaceæ. To these may belong some forms of *Maianthemophyllum*. Conwentz describes the flower of *Smilax baltica*, from the amber of Samland, and in the Oligocene and Miocene we have *S. hastata*, *S. grandifolia*, etc., whilst *S. aspera*, L., is found in the Glacial beds of Tuscany.

xxii. *Dioscorideæ.*

Of the Miocene fossils called *Dioscorites*, regarded as related to *Dioscorea* (yam), most are exceedingly unsatisfactory. The best example is named by Weber, *Maianthemophyllum petiolatum*, from the Tertiary of Bonn.

xxiv. *Iridaceæ.*

In Tertiary beds again we meet with some fossils having a general resemblance to *Iris*. Thus *Iris escheri*, Heer, Tertiary of Œningen, has a very similar type of leaf and rhizome to that of the recent *Iris*.

VII. Scitamineae.

xxv. *Musaceæ.*

A few plants have been referred to Scitamineæ (plantain, ginger, cannas, etc.). Thus Saporta has described from the Eocene of Aix and Italy plants which he calls *Musa speciosum*, and *M. longævum*.

[1] The earlier Palæozoic and Mesozoic *Yuccites* are doubtless leaves of *Cordaites*, etc., but see Arber, E.A.N. "Trans. Linn. Soc.," vol. vii., 1907, p. 109.

These are known only from the leaves, which exhibit a form of venation characteristic of the living forms.

In the Miocene of Bohemia, Schimper has distinguished another form by the name *M. bilinicum*. In the North American Tertiaries, Lesquereux recognises a species he names *M. complicatum*, whilst his *Zingiberites dubius* is perhaps doubtfully referable to Musaceæ.

xxvi. *Zingiberaceæ.*

Heer records *Zingiberites* from the Upper Cretaceous of Greenland, Atane, and the Tertiary of Switzerland and Samland, so that, whatever value we may place upon these resemblances in leaf-form, the group would seem to have been well established in Tertiary times. In the Eocene of Paris, *Anomophyllum* and *Anomocarpum* have been detected.

xxvii. *Cannaceæ.*

The *Cannophyllites* of the Parisian Eocene is thought to represent a fossil *Canna*.

VIII. Microspermæ (Gynandræ).

xxx. *Orchidaceæ.*

The group Microspermæ is considered on *à priori* grounds to have existed in Tertiary times. Massalongo, indeed, describes forms of fossil plants representing bulbs with leaves from the Eocene of Monte Bolca, renowned for the perfection of its fossil-, insect-, and fish-remains. These he designates *Protorchis* and *Palæorchis*. Many fossils assigned to Cyperaceæ and other groups might equally well be placed under this heading, so little do we know them, as yet, except by their external characters.

Summarising briefly these results, we find that of the families of monocotyledons examples of all but the following have been recorded from Cretaceous, Tertiary, or Post-Tertiary rocks, viz. :—

Restiaceæ, Pontederiaceæ, Amaryllidaceæ, Taccaceæ, Marantaceæ Burmanniaceæ, or, in other words, out of some thirty families twenty-four are represented in a fossil state.

If all the fossil monocotyledons, however, that have rapidly been passed in review be regarded as authentic—and many of these have been noted as doubtful or errors—they would not form so abundant a flora as that of the Coal-measures itself, even if we include the whole of the fossil monocotyledons from the earliest beds up to the most recent or latest.

The first forms to appear come, as we have seen, from the Cretaceous of Europe or America, and all earlier fossils assigned to them are doubtful.

In speaking of the advent of Angiosperms, Professor Seward in

his presidential address at the Southport meeting of the British Association,[1] remarks:—

"One interesting fact as regards the composition of the Jurassic flora is the absence of any plants that can reasonably be identified as Angiosperms. In the Wealden flora of England no vestige of an Angiosperm has been found; this statement holds good also as regards Wealden floras in most other regions of the world. On the other hand, as soon as we ascend to strata of slightly more recent age we are confronted with a new element in the vegetation, which with amazing rapidity assumes the leading rôle. It is impossible to say with confidence at what precise period of geological history the Angiosperms appeared. When the rocks that now form the undulating country of the Weald were being accumulated as river-borne sediments on the floor of an estuary, this crowning act in the drama of plant evolution was probably being enacted."

Sir Archibald Geikie, in his "Text-book of Geology,"[2] gives a general summary of the flora of the Cretaceous system throughout the world, which may be quoted as follows:—

"The Cretaceous system, both in Europe and North America, presents successive platforms on which the land-vegetation of the period has been preserved, though most of the strata contain only marine organisms. This terrestrial flora possesses a great interest, for it includes the earliest known progenitors of the abundant dicotyledonous Angiosperms of the present day. In Europe, during the earlier part of the Cretaceous, it appears to have closely resembled the vegetation of the previous ages, for the same genera of ferns, cycads, and conifers which formed the Jurassic woodlands are found in the rocks. Yet that Angiosperms must have already existed is made certain by the sudden appearance of numerous forms of that class, at the base of the Upper Cretaceous formations in Saxony and Bohemia, whence forms of *Acer*, *Alnus*, *Credneria*, *Salix*, and other dicotyledons have been obtained. Similar evidence of the appearance of *Quercus*, *Sassafras*, *Platanus*, and many other dicotyledons, in the midst of abundant ferns and cycads has been obtained from the Lower Cretaceous series of the Spanish peninsula and the United States. Still more varied and abundant is the flora preserved in the Upper Cretaceous formation in Westphalia, from which many species of dicotyledonous plants have been obtained belonging to the genera *Populus*, *Myrica*, *Quercus*, *Ficus*, *Credneria*, *Viburnum*, *Eucalyptus*, etc., besides algæ, ferns, cycads, conifers, and various monocotyledons."

At Aix-la-Chapelle, in beds of the same age, Angiosperms are also met with, including *Caulinites*, *Dryophyllum*, *Myricophyllum*, *Ficus*, *Laurophyllum*, and several species of *Pandanus*. Many of these are proteaceous, and recall the existing floras of Australia or the Cape, where *Banksia*, etc., flourish, thus denoting a great difference in climate.

In North Greenland, Heer discovered and described large numbers

[1] 1903, 1904, p. 23 (of reprint).
[2] Pp. 1163–5.

of fossil plants, including not only ferns, cycads, conifers, *Ginkgo*, etc., but such monocotyledons as *Arundo*, *Potamogeton*, etc., and dicotyledons, *e.g.* poplar, myrica, oak, fig, walnut, plane, dogwood, magnolia, eucalyptus, ilex, buckthorn, cassia, etc.

In the Potomac formation of North America, again, and the Laramie group an extensive flora occurs. Fifty per cent. of the Angiosperms discovered are referred to existing genera or species, *e.g.* oak, willow, birch, plane, poplar, maple hickory, fig, tulip-tree, sassafras, laurel, cinnamon, buckthorn, and palms, *e.g. Sabal*, *Flabellaria*, as well as other monocotyledons and cycads, conifers, etc.

In the Potomac formation 198 genera and 737 species of plants were found, and of these 8 are monocotyledons. There are, moreover, 92 genera and 320 species of dicotyledons. Of these Geikie remarks: "Of these higher forms of vegetation the more peculiar seem to be what are known as 'generalised types,' indicating the great antiquity of the flora." Amongst the dicotyledonous genera are *Aralia*, *Cinnamomum*, *Ficus*, *Hedera*, *Ilex*, *Juglans*, *Laurus*, *Magnolia*, *Myrica*, *Platanus*, *Quercus*, *Rhamnus*, *Salix*, *Sassafras*, *Vibirnum*. Thus both monocotyledons and dicotyledons appear upon the same horizon. Are the former an offshoot of the latter, which are so far as we know most predominant, or are the latter an offshoot of the former? Are the monocotyledons monophyletic, and derived from dicotyledons, and are these in turn descended from a primitive pro-Angiosperm? This question may be best discussed at this stage by reviewing the different theories as to their origin.

In an article upon the "Phylogeny and Taxonomy of the Angiosperms,"[1] Mr C. E. Bessey approaches the subject from three points of view: (1) historical, (2) ontogenetic, (3) morphological. In regard to (1) statistics are given as to the percentages of monocotyledons recorded by Schimper, Lesquereux, and Durand, from the Triassic to present times. We reproduce only those referring to Cretaceous and later epochs, since earlier forms are doubtful or erroneously regarded as monocotyledons.

In regard to these, Bessey remarks, "making due allowance for possible errors of determination, we find that by the end of the Jurassic period the monocotyledons were probably represented by members of the groups (orders) Apocarpæ, Coronarieæ, Calycinæ, and Glumaceæ.

"To these we may add, in the Cretaceous,[2] a few representatives of the Epigynæ. It is interesting to note that the monocotyledonous plants of the Tertiary have been referred mainly to the hypogynous orders, and that none have been identified as representing the Microspermæ. Apparently the evolution of the monocotyledons began with hypogynous species and proceeded toward those in which epigyny is most marked. Orchids are doubtless of very late evolution, so late in fact that none have been preserved as fossils."[3]

[1] "Botanical Gazette," 1897, pp. 145–178.
[2] We exclude pre-Cretaceous plants.
[3] *Vide*, however, notes under this heading, *ante*.

He arrived at the following conclusions in so far as monocotyledons are concerned :—" 1. It is probable that monocotyledons and dicotyledons appeared at about the same time, namely early in the Mesozoic or late in the Palæozoic.[1] 2. The hypogynous monocotyledons appear to have preceded the epigynous monocotyledons, and similarly the petaloideous hypogynous species seem to have somewhat preceded the spadiceous and glumaceous species."

Orders.	Cretaceous.		Eocene.	Miocene.	Present.
	Lesquereux.	Schimper.			
Apocarpæ (Alismaceæ, Triurideæ Naiadaceæ)	12·5	26·6	29·3	16·1	1·
Coronariæ (Stemonaceæ, Liliaceæ, Pontederiaceæ, Philydraceæ, Xyridaceæ, Mayaceæ, Commelinaceæ, Rapateaceæ).	25·0	6·6	4·3	19·4	14·0
Nudifloræ (Pandanaceæ, Cyclanthaceæ, Typhaceæ, Aroideæ, Lemnaceæ)	12·5	33·3	14·1	7·0	5·5
Calycinæ (Flagellariaceæ, Juncaceæ, Palmaceæ). . .	12·5	26·6	22·8	21·8	8·7
Glumaceæ (Eriocaulaceæ, Centrolepidaceæ, Restiaceæ, Cyperaceæ, Gramineæ). .	12·5	...	25·0	28·3	31·6
Hydrales (Hydrocharitaceæ) .	0·0	0·0	1·1	1·6	·05
Epigynæ (Dioscoreaceæ, Taccaceæ, Amaryllidaceæ, Iridaceæ, Hæmodoraceæ, Bromeliaceæ, Scitamineæ) . .	25·0	6·6	3·3	5·6	14·0
Microspermæ (Burmanniaceæ, Orchidaceæ). . . .	..	0·0	0·0	0·0	25·7

The occurrence of *Alismacites*, on the one hand, in the Wealden, and *Liriodendron*, *Magnolia*, and other primitive dicotyledonous genera in the Cretaceous of Europe and America, and the persistence of Bennettiteæ in the Mesozoic floras with a broadly homologous floral structure is a fact which cannot be ignored in studying the origin of Angiosperms as revealed by the records of fossil evidence.

As a broad generalisation it is the only outstanding feature which suggests any material for the construction of a phylogenetic scheme, and must therefore be accepted as a working hypothesis.

Thus palæontology leads us so far. The remaining links in the chain must be supplied from the study of the embryology, morphology, ecology, and the systematic characters of the group.

[1] We prefer to say *late* in the Mesozoic.

EXPLANATION OF PLATES.

(*N.B.*—The figures are very diagrammatic.)

PLATE I.

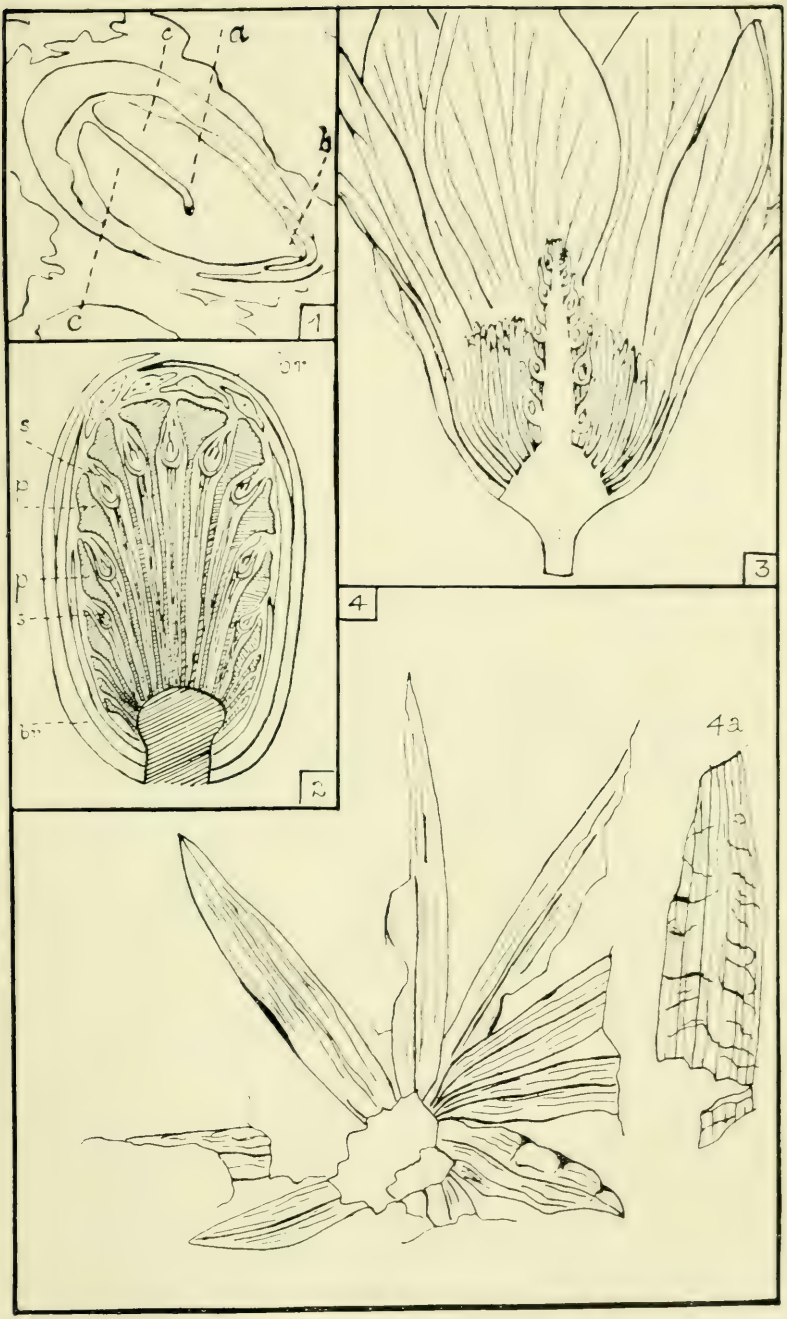
Fig. 1. Longitudinal section through the embryo of *Bennettites gibsonianus*. *a*= plumule; *b*=radicle; *c*=cotyledons. ("Scott. Fossil Botany," 6th edition, 1900, fig. 150.)

Fig. 2. Radial section through fruit of *Bennettites gibsonianus*. *rc.*=receptacle; *br.*=bracts which overlap at the top; *s.*=seeds borne on longitudinal pedicles, arising from the receptacle, showing dicotyledonous embryos; *p.*=dilated ends of inter-seminal scales, which become confluent to form the pericarp. ("Scott. Fossil Botany," 6th edition, 1900, fig. 148.)

Fig. 3. Longitudinal section through the flower of *Magnolia yulan*, to illustrate general arrangement of floral organs, and for comparison with *Bennettites gibsonianus*. (After Baillon, "Nat. History of Plants," fig. 167.)

Fig. 4. *Eriocaulon? porosum*, Lesqx. Lower Eocene, Sand Creek, N. America. (After Lesquereux, "The Tertiary Flora," 1878, pl. xvi. figs. 2, 2*a*.) Transitional between Cretaceous and Tertiary.

[The author wishes to acknowledge his indebtedness to Messrs. A. & C. Black, Lovell Reeve, and The Macmillan Co. for permission to copy figures from works by Dr. D. H. Scott, Bentham and Hooker, and Strasburger respectively.]



A. R. Horwood. Plate I.

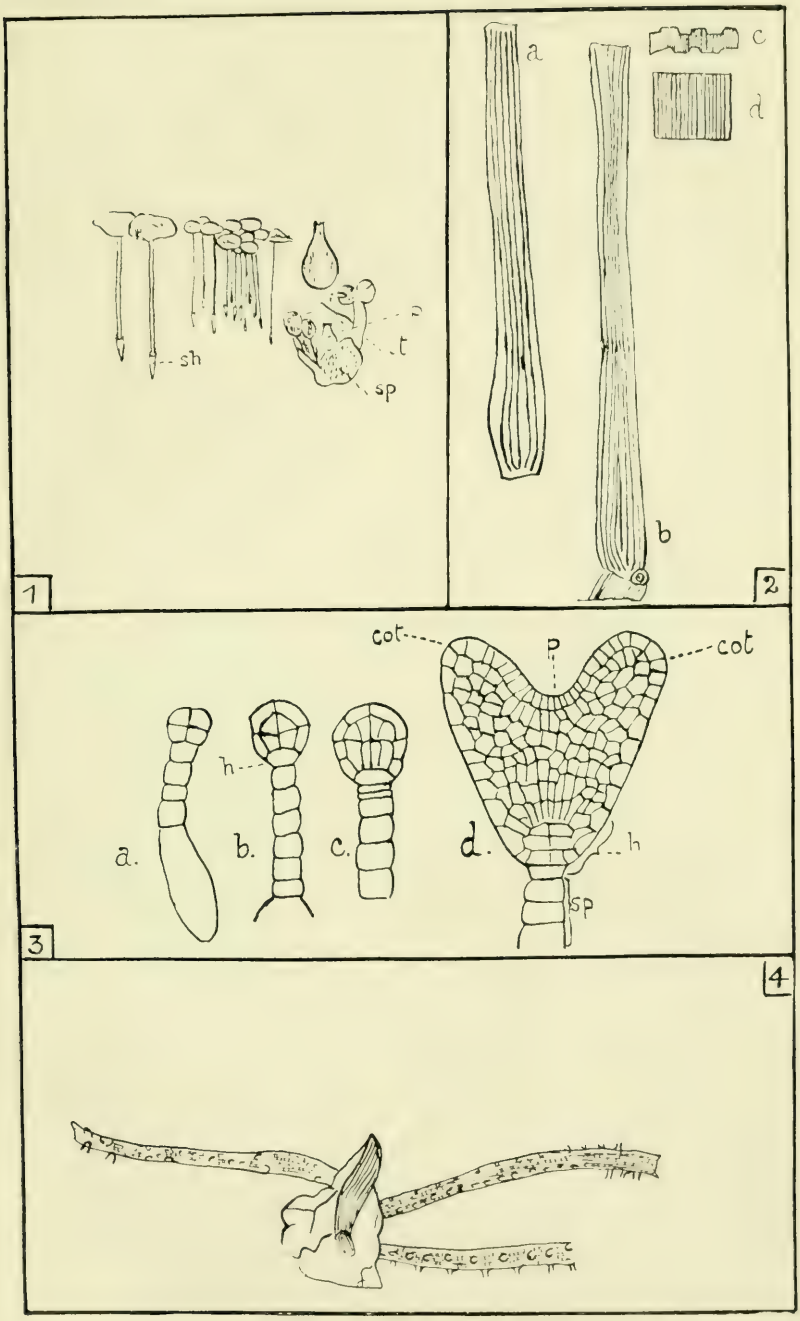
PLATE II.

Fig. 1. *Lemna minor*, Linn. Plant natural size, and with flower and fruit enlarged to show reduced types of floral organs. (After Bentham and Hooker, "British Flora," 1865, fig. 939.) *p.* = pistil; *st.* = stamen; *sp.* = spathe; *sh.* = sheath.

Fig. 2. *Phragmites œningensis*, A. Br. (After Lesquereux, *ibid.*, pl. viii. figs. 1, 2.) Tertiary, Golden Canon City, N. America.

Fig. 3. Stages in the development of the embryo of *Capsella bursa pastoris*. *sp.* = suspensor; *cot.* = cotyledon; *h.* = hypophysis; *p.* = plumule; to show division of cells in suspensor for comparison with epibasal quadrants in Jungermannieæ. (After Strasburger, "A Text-book of Botany," 1903, fig. 399.)

Fig. 4. *Arundo goepperti*, ? Münst. (After Lesquereux, *ibid.*, pl. viii. fig. 3.) Tertiary, Golden River, N. America.



A. R. Horwood. Plate II.

Recent Additions to the Caithness Flora.

By Arthur Bennett, A.L.S.

The Rev. D. Lillie of Watten Manse wrote me that his daughter, Miss Isabel Lillie, had collected in Caithness in 1910 and submitted her specimens to Dr. J. W. H. Trail of Aberdeen.

Dr. Trail has kindly sent me a list of what seem additions, though many are simply casuals or aliens :—

Nasturtium microphyllum, Reichb.—Watten Loch.
†*Geranium Phæum*, L.—Outside garden, Lybster.
†*Trifolium agrarium*, L.—Pasture, Stanstill, Bower.
Lathyrus montanus, Bernh., var. *tenuifolius* (Roth).—Banks of Reisgill Burn.
**Rosa rubiginosa*, L.
**Saxifraga umbrosa*, L.—Among trees, Lybster.
**Sedum album*, L.—Old wall and bridge, Dunbeath.
**Sedum stoloniferum*.—Wall in Castletown.
Callitriche vernalis, L.—Loch Watten.

Adoxa moschatellina, L.—From South Caithness in 1908.
**Campanula latifolia*, L.—Weed in manse garden at Watten.
†*Linaria Cymbalaria*, L.—Garden walls, Swiney, Lybster.
†*L. vulgaris*, L.—Old garden, Dunbeath.
†*Mentha piperita*, L.—Forse, Latheron.
Utricularia vulgaris, L.—Probably not characteristic.
Carex curta, Good. ?
†*Bromus racemosus*, L.

The following have been found by other collectors :—

Viola Lloydii, Jord.—Thurso. "Anns. Scot. N. Hist.," 1911, p. 98.

Trifolium arvense, L.—Edge of oatfield, Milton, near Wick. Mr. A. Henry sp.

†*Lamium maculatum*, L.—Roadside, edge of a wood at Castletown. Mr. A. Henry sp.

Melampyrum pratense, L., var. *montanum* (Johnst.).—Scouthall wood. Dr. Davidson sp.

These comprise about nine real additions.

Mr. C. B. Crampton has published "The Vegetation of Caithness considered in relation to the Geology" and there has added the undermentioned species to its flora :—

Corydalis claviculata, DC.—In a few places along the banks of the Langwell and Berriedale Waters. This is an interesting addition to this northern flora; it seems wanting in all Sweden, occurs very locally in W. Norway (Slavenga) and S. Norway (Christianssand), in Denmark in several places, and North Germany, but not recorded

for Finland, the Faroes, or Iceland. Occurs in East (Grant sp.) and West Sutherland (Marshall sp.).

Filago minima, Fr.—Sandy places along Berriedale Water. On record for Ross and E. Sutherland, but not further north. Unknown in Finland, boreal Norway, and boreal Sweden.

Vaccinium uliginosum, L. — Northern flank of Small Mount (1750 ft.), in the Langwell Forest. Found in Sutherland, Orkney, and Shetland!.

Vaccinium Oxycoccus, L.—In the Langwell Forest, near the Dubh lochs of Skielton. Recorded up to E. Sutherland (Marshall, 1909).

Milium effusum, L.—In the Achorn Gorge near Dunbeath. In E. Sutherland. Grant sp.

Melica nutans, L.—Rocky banks of the Berriedale Water with birch scrub; scarce. W. Sutherland (Marshall).

Bromus ramosus, Huds.—Achorn Gorge, near Dunbeath, and on the landslip beneath the cliff near Borgue. This is not an addition, though so given, but it being recorded under the name of *B. asper*, Murray, no doubt led to the mistake. It was found by Robert Dick at Dirlot, and I have seen it from the Forss Water.

Asplenium viride, Huds.—Rock crevices on Smean (1500 ft.). In E. and W. Ross and Shetland.

The above are an addition of seven species to the flora. The work whence these are taken enters fully into the ecological conditions of the plant-formations of Caithness from the top of Morven to the sea-coast.

The most interesting plant as regards Scotland, *Hierochloe borealis*, is not mentioned. We know from Robert Dick that the plant occurs along the Boulder Clay of the Thurso river, but it would have been of interest if the occurrence of the species had been noticed from the geological standpoint.

Mr. Crampton gives localities for other Caithness plants which are not localised in any of the published lists, as—

Carex limosa, L.—Small loch in the corrie at Yarehouse, where it grows associated with *C. dioica*, L., and *C. paniculata*, L.

Ranunculus auricomus, L.—Mr. Lillie of Swiney, Lybster, has sent me a specimen of the above species, gathered by one of the children of Boultach School, and brought to Miss Hamilton, the teacher.

This is an interesting addition to the flora, as it is not on record north of Nairn on the east coast, and of Argyll! on the west coast. In Sweden its distribution is continuous from Skane to Swedish Lapland, in Norway north to 71° 8′, and in Russian Lapland to 69° N. lat.

It also occurs in the Faroes, but not in Iceland.

Short Notes.

[*It is hoped that all will combine to make this section as complete as possible by the prompt recording of all "new records," etc.*]

Hierochloe odorata, Wahl.—I should like to correct a mistake regarding the refinding of *Hierochloe odorata* recorded by Don from Glen Calla. Mr. Arthur Bennett, in the "Annals of Scottish Natural History," October 1911, refers to a post-card he had received from the late Mr. A. Somerville, dated 14th June 1904, in which Mr. Somerville states that he possessed a letter from Mr. J. Smith Nicoll of Arbroath regarding this plant. In the letter Mr. Nicoll says that he knew a Dundee botanist who had found *Hierochloe* in Glen Calla. I have spoken to Mr. Nicoll on the subject, and he tells me that the botanist he referred to was Mr. William Smith, who, however, informs me that there must have been some misunderstanding, as he has never seen *Hierochloe*, and Mr. Nicoll himself says that he has been mistaken as to the plant found by Mr. Smith. On several occasions in May of this year I searched the Glen, but without success. R. H. Corstorphine.

Mr. G. C. Druce ("Journal of Botany," June 1912), in a note upon *Alchemilla acutidens* Buser, discovered on Ben Lawers last summer by Dr. Ostenfeld, refers specimens collected by Mr. E. S. Marshall at Inchory, Banff, and by myself in Linlithgowshire in 1910, to that species, and quotes Lindberg's descriptions of this and *A. alpestris* Schmidt, with which it has formerly been confused in Britain. It would be well if Scottish botanists would pay special attention to the genus, as *A. acutidens* may be expected in many other counties. There is also another very distinct-looking plant which occurs in Linlithgowshire for which I have been unable to obtain a name so far. M'Taggart Cowan, Jr.

Note on the Calluna-Mat Association of the Mountain Tops of the Northern Highlands.—Some description of this plant association was given in the "Vegetation of Caithness" (1911), and it is hoped in the near future to publish a fuller account of its geological and other relations as found in the Ben Armine district. Here we wish to draw attention to the habit of some of the typical plants of the association. These include, *Calluna vulgaris*, *Erica cinerea* (frequent), *Arctostaphylos alpina* and *A. uva-ursi*, *Thymus Serpyllum* (frequent), *Aira flexuosa*, *Azalea procumbens*, *Lycopodium alpinum*, *Antennaria dioica*, *Carex rigida*, and species of *Vaccinium* occur sometimes.

Some of these plants are normally creeping and prostrate, and form adventitious roots, *e.g. Lycopodium alpinum* and *Carex rigida*. But it is found that a similar habit is also common to *Calluna vulgaris*, *Erica cinerea*, and *Aira flexuosa*, as well as the species of *Vaccinium* and *Arctostaphylos*. The plants all grow prostrate in the direction of the prevailing winds, and are subjected to conditions comparable to the layering used by gardeners for the propagation of many garden plants. The wind continually erodes the surface where the plants are old and woody, thus destroying them, but the younger and more branched parts of the plants are buried in drifted material, thus inducing the formation of adventitious roots. This process results in a constant migration of the plants in a definite direction before the wind, and also leads to the peculiar wave-like troughs and ridges already described in the "Vegetation of Caithness." The type of *Calluna* is probably the form *Erikäe* of P. Graebner, since it shows the geotropic curved extremities of the smaller branches.

C. B. Crampton and M. Macgregor.

Dear Mr. Editor,—It seems impossible to arrive at a full knowledge of the British Rubi by mere collection and comparison of specimens. Might not something more be done by studying the effect on a few definite species of artificial change of environment, and of the results of crossing? If two small groups were studied in this way—say Mr. Roger's *suberecti* and their hybrids with *rhamnifolius*, *Selmeri*, *macrophyllus*, and *corylifolius*—might it not throw much light upon the whole genus, and beyond that? Short of that, might not much be done by studying the position in which definite species are growing with regard to "intermediates"? Is *R. Rogersii* = *R. plicatus* × *carpinifolius*? Does *R. suberectus* × *corylifolius* simulate *R. fissus*?

Edw. G. Gilbert.

Note on some vice-county records of *Cornus suecica*, Linn., etc.—To the list of Scottish vice-counties from which *Cornus suecica* has been recorded, given in Mr. G. G. Blackwood's interesting note in the April number of the "Review" (p. 117), must be added 87 (So. Perth) and 111 (Orkney). In the former it has long been known to grow sparingly on Ben Ledi, where it was gathered by Professor J. H. Balfour and party on 21st July 1860, and in subsequent years, as recorded in his "Botanical Excursions," pp. 309, etc. I have before me a specimen collected there so recently as July 1907. The Orkney record—from the island of Hoy—is given by Mr. Arthur Bennett in "Ann. Scot. Nat. Hist.," 1908, p. 251. To the English vice-counties should be added 59 So. Lancashire (*id.*, *ibid.*, 1911, p. 190).

William Evans.

Notes from Current Literature.

Mr. E. S. Marshall ("Journal of Botany," April 1912) in a short note records that Dr. Glück, in examining the sheets of *Utricularia* in his herbarium, identified specimens as *U. ochroleuca* R. Hartman from vice-counties 88, 98, 106, 108, and 112, as well as from Dorset v.c. 9. None of the Scottish specimens were true *U. intermedia.*

"South Kerry Plants," by E. S. Marshall ("Journal of Botany," June 1912). In this Mr. Marshall gives valuable notes upon some of the Irish Saxifrages, and describes a new variety of *S. hirsuta* as var. *acutidens.*

"Doux Labiées nouvelles pour la Provence," by Alfred Reynier ("Bulletin de la Société Botanique de France," 1911, No. 8). Contains lengthy notes on *Ballota nigra* Linn., var. *ruderalis*, and *Calamintha nepeta* Savi, *f. Gussonei.*

"Contribution à l'étude des Saxifrages du groupe des *Dactyloides* Tausch," by M. D. Luizet ("Bulletin de la Société Botanique de France," 1911, No. 8).

"Några olika typer af. *Convallaria majalis* L.," by Carl Skottsberg ("Svensk Botanisk Tidskrift," Haft 4, p. 411).

"Un *Sagina* nouveau présumé hybride: *Sagina lemovicensis*," by E. Simon. ? *S. subulata* × *procumbens* ("Bulletin de la Société Botanique de France," 1911, p. xlii).

"Un Saule peu connu de la flore de France (*Salix atrocinerea* Brot.)," by Ph. Guinier ("Bulletin de la Société Botanique de France," 1911, p. ix).

"The Grama Grasses: *Bouteloua* and Related Genera," by David Griffiths ("Contributions from the United States National Herbarium," vol. xiv. part iii.). This is a paper of considerable value, containing good photographs and dissections of the various species described.

"New or Noteworthy Plants from Columbia and Central America," by H. Pittier. ("Contributions from the United States National Herbarium," vol. xiii. part xii.). A large number of the species described are trees, some of which are of considerable commercial value.

"New or Interesting Mosses from Panama," by R. S. Williams ("Contributions from the United States National Herbarium," vol. xvi. part i.).

"Contribution à l'étude des Muscinées de l'Ouest et du littoral," by A. Coppey ("Bulletin de la Société Botanique de France," 1911, p. xxi).

"On the Periodicity of the Phytoplankton of some British Lakes," by W. and G. S. West ("Journal of the Linnean Society," May 1912).

"Notice sur les spores des *Licheni blasteniaspori* Mass," by Abbé Hue ("Bulletin de la Société Botanique de France," 1912, p. lxvii).

"Notes Lichénologiques," by M. Bouly de Lesdain ("Bulletin de la Société Botanique de France," 1911, No. 8). Contains descriptions of a number of new species.

"On the Brown Seaweeds of the Salt-Marsh," by Sarah M. Baker ("Journal of the Linnean Society," February 1912).

"La Vendée considerée comme unité géographique et caractérisée par sa flore," by F. Hy ("Bulletin de la Société Botanique de France," 1911, p. xxvi).

"The Relation of Ohio Bog Vegetation to the Chemical Nature of Peat Soils," by Alfred Dachnowski ("Bulletin Torrey Botanical Club," vol. xxxix., No. 2).

"An Ecological Study of a Cambridge Woodland," by R. S. Adamson, M.A., B.Sc. ("Journal of the Linnean Society," February 1912).

"Om en planmässig vaxtgeografisk undersökning of Sverige," by H. Wilh. Arnell ("Svensk Botanisk Tidskrift," Haft 4, p. 418).

"Observations on the Degree of Stomatal Movement in Certain Plants," by B. E. Livingston and A. H. Estabrook ("Bulletin Torrey Botanical Club," January 1912).

"Researches on Heredity in Plants," by Professor F. E. Weiss ("Memoirs and Proceedings of the Manchester Literary and Philosophical Society," vol. lvi., part i.).

Reviews, Book Notices, etc.

PRODROMUS FLORÆ BRITANNICÆ. By FREDERIC N. WILLIAMS. Part IX., comprising the fourteen families in the four orders of Rhamnales, Gruinales, Hippocastanales, and Tricoccales. Pp. 477–532. Brentford: C. Stutter. March 1912.

ONE year has elapsed since Mr. Williams published Part VIII. of his "Prodromus." In this last part we have some interesting reflections on some British species. Of course, there are some name-changings and alterations; this seems to be inevitable in each succeeding publication. Whether we shall be plunged into as great a muddle as our American confrères, remains to be seen.

It is not necessary here to enter into the scheme of arrangement—this has been ably commented on in the notices of earlier parts, *i.e.*

by Mr. Hiern ;[1] so that the treatment of the species may be noticed, and especially of the varieties and forms, which it seems difficult to keep to any standard. For example, *Callitriche*, a genus very difficult to diagnose without fruit, has distributed among its species no less than twelve, exclusive of the normal forms. As one who has cultivated these plants, I do not believe they will stand the test ; they are simply individual variation, ever reverting to their original type.

Mr. Williams uses the genus *Frangula* Tour. for *Rhamnus Frangula* L. as *F. alnus* Miller, giving reasons for so doing. For *Linum perenne* L. he uses *L. anglicum* Miller ; his reasoning here seems to lend itself to the alteration. For *L. angustifolium* Huds. (1778) we have *L. hispanicum* Miller (1768). We are told that *Erodium cicutarium* Aiton has no varieties in Britain ; to this some will demur. In some cases the distribution given seems hardly full enough, *i.e. C. maritimum* Aiton.

In the genus *Callitriche* we have *C. platycarpa* as a species apart from *C. stagnalis*, with five named varieties, etc., under them. Hegelmaier in his monograph[2] combined them, but he kept *C. pedunculata* DC. as a species.

C. angustifolia Hoppe is kept as a species separated from *C. intermedia* Hoff. Certainly this has some characters that seem to commend this, but they require testing by cultivation, and the majority of Continental authors place it under *C. verna* L. seg. Under one of these he remarks (p. 509), "The difference in form between the floating leaves and the lower leaves is very marked" ; but surely this is only a passing state. I believe it to be impossible to separate these plants by leaves alone, except in the second section (*i.e. truncata* and *autumnalis*).

He keeps up *C. pedunculata* DC. as a species, and observes, "It is interesting from the fact that it forms its fruit in early summer." But this is simply because the water is evaporated earlier and the plants exposed to more sun, and within a few yards *C. obtusangula* Le Gall. (submerged) may be found in good fruit at the same time.

C. verna he quotes as of Withering, "Bot. An. Veg. Brit.," p. 2, 1776, as *C. verna* L. has no meaning. But is Withering's description (quoted) enough to determine this ?

C. autumnalis L. (October 1755) is replaced by *C. hermaphroditica*, Juslenius, "Cent. Plant.," n. 89, p. 31 (February 1755), whose description consists of five words ; but I suppose Haller's reference must be accepted.

The distribution of this species is of interest in relation to *C. truncata* Guss. It extends from Shetland ! south to Anglesea ! and Cheshire ! (53°·16 N. lat.), while *truncata* extends north to Nottinghamshire at 53°·26′, so they slightly overlap. The record of "Devon S." in "Topl. Botany" is probably an error, but it may have been *truncata* not then separated in Britain.

C. polymorpha Lönn. Mr. Williams passes with scant notice ; his

[1] "Jour. of Botany," p. 229, 1909.
[2] "Mon. Gatt. Callitriche," 1864.

observation on Lönnroth's paper only refers to his "Thesis, 1854," but in the "Bot. Notiser" for 1867 he gives excellent drawings of all the Swedish species and amplifies the 1854 work.

Under *Polygala vulgaris* L., var. *grandiflora* Bab., he remarks, "There are only two British specimens so named in the Herb. Mus. Brit." But neither is Babington's plant! or like it. The Faroe one also is not the variety. The Irish plant is certainly a variety, and Mr. Ball's herbarium name of *buscifolia* well describes it; but this was occupied, and so Nyman, "Consp. Fl. Europ.," p. 83, 1878, named it *P. Ballii*.

Mr. Williams sinks all the plants called (in Britain) *P. amara*, *P. amarella*, *P. uliginosa*, and *P. austriaca* under *P. amara* L. (1759).

Under *Empetrum nigrum* L. it might have been recorded that Boner found it in the Amberly Wildbrooks (Sussex) and Mitten in Dorset.

Under the Box he does not refer to Babington's note ("Phytologist," 21/1/1853) from Asser's "Life of King Alfred."

The remainder of this part includes five species of *Euphorbia*, and keeps up the original and suggestive ideas of former parts, though to some it may seem that the treatment of the species is unequal, especially as to distribution.

THE SHINGLE BEACH AS A PLANT HABITAT. By F. W. OLIVER. (Plate IV. and Eight Figures in the Text.) "New Phytologist," vol. xi., No. 3, March 1912.

IN this interesting and instructive paper Professor Oliver gives the first instalment of what we hope may prove to be a monograph on the shingle beaches of this country, which he is studying from the point of view of their relations to plant habitat.

After shortly discussing the origin of the four principal types of shingle beaches, viz. (1) the Fringing Beach, (2) the Shingle Spit, (3) the Shingle Bar, (4) Apposition Beaches, he proceeds to give an account of the shingle spit and its modifications.

In this certain new facts and views of geological importance are set forth, such as can only be discussed fairly elsewhere; but attention should be especially given to the following points. The spit is looked upon as having a phase of youth, under the organising influence of the littoral current, when its growth is mainly in length, this being followed by a more or less prolonged phase of hook-formation—a phase of maturity—when the spit becomes subject to increasing tidal scour, which, in conjunction with heavy onshore gales, leads to the transfer of material and the production of a landward hook at its termination. Further, there may be reversions to the juvenile straight-growing phase, and alternations of such phases with those of maturity lead to spits having groups of hooks distributed along their length.

The mobility of the shingle on shingle spits is shown to be due to (1) wave impact scattering stones over the crest, and, where more

effective, leading to finger-like tongues of shingle to the rear of the spit, lying in the direction of principal wave impact. When high spring tides are accompanied by gales, the crest of the spit may be awash and the impact of the waves may then even promote a landward creep of the bank, the mobility of the bank being increased by supersaturation. (2) Percolation, in cases where the bank is steep-sided and the level of high tide above that of the salt-marsh enclosed by the spit. This leads to the erosion of "ravines" by landslip, and the formation of a terrace, by gravitation and detrital faces, on the landward side of the bank, the "ravines" being separated by buttresses of shingle in a quiescent state. (3) Undercutting of the bank on the lee side by tidal or other currents, which sometimes plays an important part in regulating the landward creep of the bank.

Shingle beaches, and especially shingle spits, are shown to belie their appearance both in regard to the soil and to the water they contain. The supply of soil is derived from drift, that from the salt-marshes being considered of more importance than that from the sea, on account of its greater quantity, its richer manurial value, its frequent interstratification with the shingle on the lee side of the bank, and on account of its being the great agency by which certain seeds are sown and placed under favourable conditions for germination. With this is contrasted the enduring sterility of the apposition type of shingle beaches, where contact with tidal waters is denied.

The water of shingle banks is shown to be astonishingly copious and practically free from salt above the true salt-zone, and, moreover, suffers no diminution during periods of prolonged drought.

The types of plant habitat on the shingle spit are classified as:—

(1) *The Sea Face*, reached by ordinary tides and barren of vegetation.

(2) *The Storm Shelf*, with chiefly prostrate species of *Atriplex* and sometimes *Beta maritima*.

(3) *The Crest*, where wind exposure is a serious check to vegetation, and sometimes distinguished as forming the last stronghold of plants endowed with the capacity of creeping up the shingle from the landward side.

(4) *The Back of the Bank*, with its sheltered "ravines," forming the chief region of vegetation, which shows indications of being separable into (1) a vegetation of dormant areas, and (2) that of areas in an unstable condition.

(5) *The Terrace*, the gathering-ground of escapes from the salt-marsh.

(6) *The Hooks*, which, apart from the terminal hook, are passive and consolidated, and may in certain cases yield distinctive plants as *Inula crithmoides* or *Limonium binervosum*.

In conclusion it may be said that the paper clearly demonstrates the close relation between ecological habitat and the effects of the geological factors of surface change in the shingle spit, and in its method and thoroughness forms an outstanding example of how ecological work should be prosecuted.

A Monograph of the British Desmidiaceæ. By W. and G. S. West. Vol. iv. Ray Society, London, 1912. Pp. xiv + 191, Plates 96–128. Price 25*s.* net.

We are indeed glad to welcome the fourth volume of this masterly work, containing as it does the completion of the exceedingly difficult genus *Cosmarium*. No one who is not a student of this most complex subject can appreciate the amount of knowledge and labour required for the compilation of such a work, and the authors have conferred an incalculable benefit upon students by the undertaking.

Besides the completion of the genus *Cosmarium*, the genera *Xanthidium* and *Arthrodesmus* are dealt with, and the genus *Staurastrum* started, the first forty-one species being described and figured.

The authors describe three new species (as well as many varieties), viz. *Xanthidium Orcadense*, from a sphagnum bog in the Orkneys, and which the authors in 1896 described as *X. Robinsonianum*, from which it differs, however, "in its open sinus and in its more scattered and more reduced spines, and the rounded and less evident central protuberance"; *Staurastrum pilosellum*, from Cornwall; and *S. inflatum*, from W. Yorks.

The authors' treatment of the genus *Staurastrum* is worthy of note. Attempts to split the genus upon natural principles having failed, they group it in two divisions:

Division I. Angles of semi-cells not produced into processes.

Division II. Angles of semi-cells produced into processes.

Each of these divisions, again, is divided into several sections. This treatment seems in every way satisfactory.

As in former volumes, the book contains plates of all species and varieties described, while another valuable feature is an additional bibliography which brings the literature up to date.

Clare Island Survey. Part XIV.: Lichens. By Miss Annie Lorrain Smith, F.L.S. Dublin: Hodges, Figgis & Co., 1911. Price 6*d.*

The Report on the lichens of Clare Island made by Miss A. L. Smith is of very great interest, as it is the work of an accomplished lichenologist, who has quite recently completed the monograph of British lichens commenced by the Rev. J. M. Crombie. Miss Smith devotes six introductory pages to the geographical features of Clare Island and district, the rocks, and the ecological factors, which especially determine the distribution of these plants. The rocks are covered by grass, moor, and bog, but are often "denuded of soil, and lie exposed to sun and wind—ideal situations for lichens." In some parts rock specimens abound, being "of a more or less alpine character." Quartzite, typically barren, here yielded *Rhizocarpon geographicum*, as elsewhere. Numerous corticolous species were found in the woodlands. Previous work in this district had been limited, and was mainly due to Larbalestier, who died only last year.

But collections were made in 1909 and subsequently by Miss M. C. Knowles (Dublin), W. West (Bradford), W. A. Wattam (Huddersfield), and by Miss Smith and others. The result was a collection of 280 species, of which only 30 are noted in Adams' paper, for subprovince Co. Mayo, of which Clare Island forms a part. Though some had been found in Galway, 30 to 40 are new to Ireland—a very good record. Nine noted by Adams were not seen, so that such species as *Roccella fuciformis* and *Collema flaccidum* may be extinct.

Miss Smith remarks that Clare Island (and district) is specially favourable to lichens. An extremely interesting and graphic account, pleasantly written, is given of the occurrence of different dominant species. Inland *Lecidea rivulosa* forms patches 9 feet by 3 feet. It is noted that *Parmelia saxatilis* passes over to the allied species *P. omphalodes*. Observations such as these show how indispensable field-work is to the interpretation of plant affinities and life-history. The luxuriance of lichen growth may be illustrated by the fact that a tree trunk was almost covered by *Collema nigrescens*, a feature that here may be best paralleled in England in the South.

Some rare species are recorded, *e.g. Arthonia subvarians*, etc. Miss Smith truly notes that the distribution of lichens is ecological even more than geographical. But it is clear that the geographical or physiographical conditions of the west coast of Ireland are primarily responsible for not only the wealth of moisture-loving cryptogams, but also for the characteristic phanerogams which are peculiar to this humid and warm region. In the enumeration of species the ecological distribution is given by denoting the habitat, tree or bark, rock and wall, ground and soil, by the letters B, R, and G. The list itself is of considerable interest and value, and is an important contribution to lichenological literature.

A Short Flora of Cambridgeshire, chiefly from an Ecological Standpoint. With a History of its Chief Botanists. By Arthur H. Evans and others ("Proceedings of the Cambridge Philosophical Society," vol. xvi., part iii.).

This work has been written, as the author says, with the intention of bringing Babington's work on the county up to date, and this it succeeds in doing excellently. The book is divided into four parts, viz.:—I., which gives a biographical sketch of the chief local botanists from the time of Ray downward to present time; II., which deals with the physical features with its geological formations and attendent floras; III., an annotated list of some of the rarer plants and extinct species; IV., a general list of species with the numbers of the division in which found; while V. deals with the Thallophyla.

It is distinctly unfortunate that in the title there should be the somewhat startling announcement, "chiefly from an ecological standpoint," as we find the only claim it can have to deal with ecology is that the county has been divided up into divisions following roughly certain "geological formations." We fear this scarcely

justifies such a title ; indeed, it can be seen, from the district numbers placed after many plants, how little it tells of the ecology of any species. However this may be, the volume will be of great assistance to all field-workers in the county. The chapter upon the Characeæ, brought up to date by the Messrs Groves, is a very good example of the thorough manner in which these excellent workers carry out their investigations. The chapter on the Bryophyta is by the Rev. P. G. M. Rhodes, and the Algæ by G. S. West, this latter being an extremely comprehensive and masterly study of the algal flora of the county. The final chapter, upon the Fungi, is by F. T. Brooks, and gives a list of the higher fungi recently found in the county.

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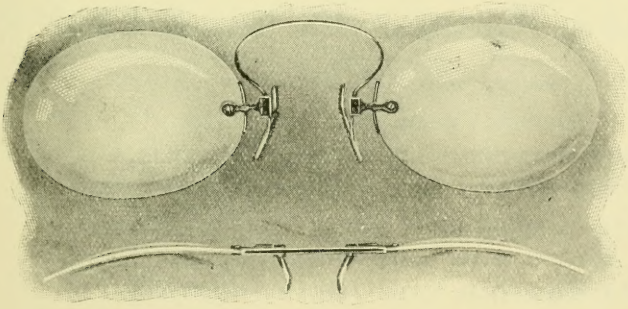

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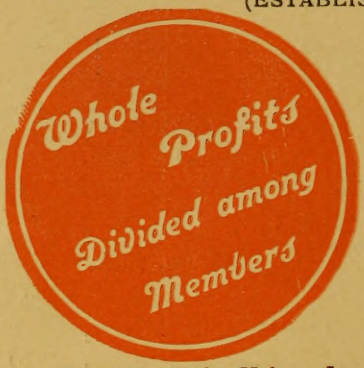

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